



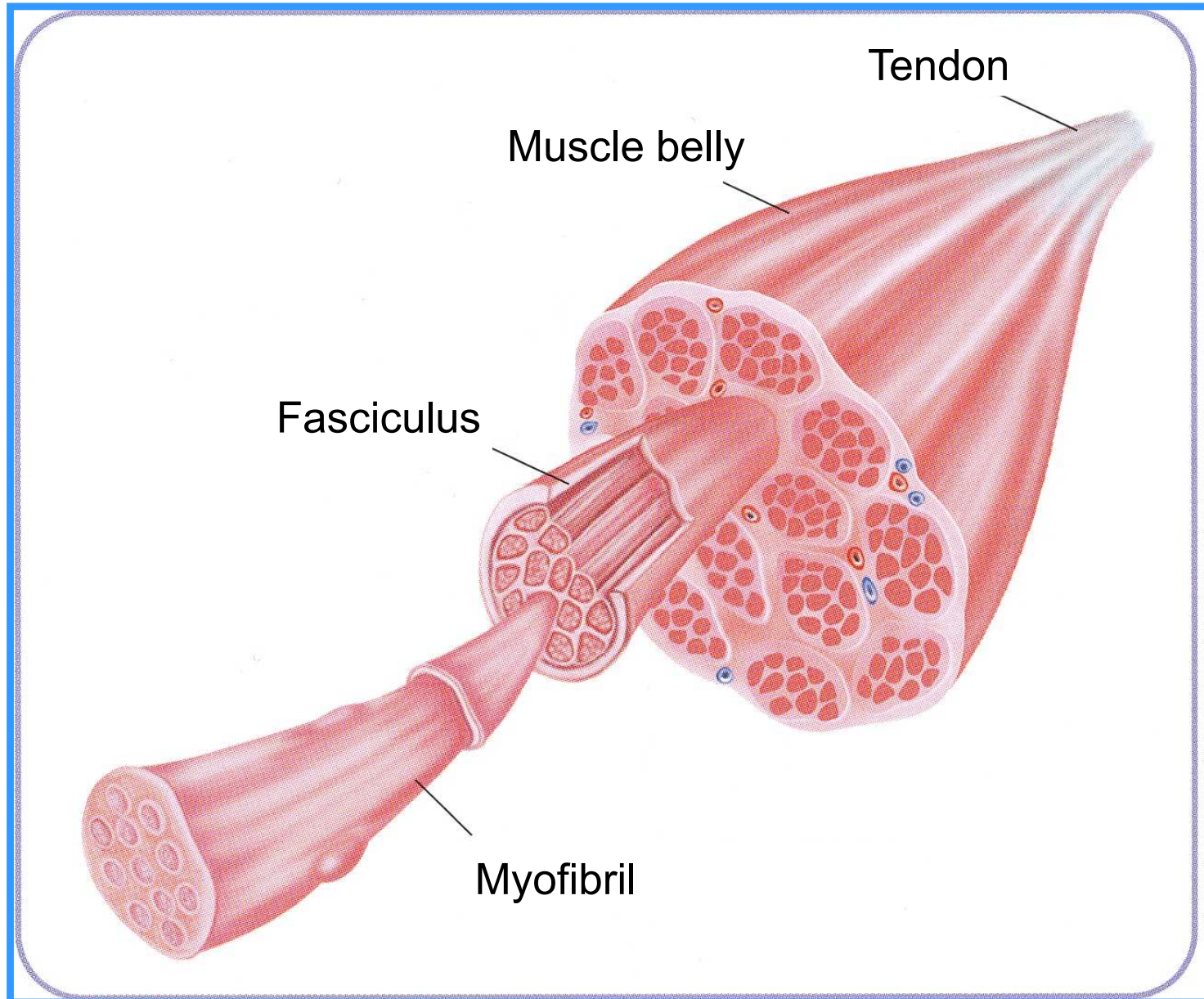
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

# SECURING ENERGY FOR SPORTS PERFORMANCE

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Projekt: Zvyšování jazykových kompetencí pracovníků FSpS MU a inovace výuky  
v oblasti kinantropologie, reg.č.: CZ.1.07/2.2.00/15.0199

# Muscle fiber



# Type of muscle fibers

**Key criteria for the classification of types of muscle fibers:**

- 1. Ability to supply sufficient energy for muscle contraction**
- 2. Ability to resist fatigue**

**We distinguish:**

**Red**

**White**





**or**

**Type I.**

**Type IIa,  
IIx**





# Basis characteristics

## Type I (red)

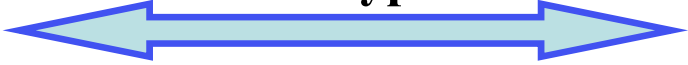
-  Resist fatigue
-  High capacity for aerobic metabolism
-  Unsuitable for activities with high loading rate
-  Low anaerobic performance

slow

## Type II (white)

-  fast defatigable
-  High capacity for anaerobic metabolism
-  Suitable for activities with high loading rate
-  Low anaerobic performance

fast

	<b>Fiber types</b> 		
	<b>slow</b>		<b>fast</b>
<b>Characteristic</b>	<b>Type I</b>	<b>Type IIa</b>	<b>Type IIx</b>
Motor neuron size	Small	Large	Large
Nerve conduction velocity	Slow	Fast	Fast
Contraction speed	Slow	Fast	Fast
Relaxation speed	Slow	Fast	Fast
Fatigue resistance	High	Intermediate/Low	Low
Force production	Low	Intermediate	High
Power output	Low	Intermediate/High	High
Endurance	High	Intermediate/Low	Low
Aerobic enzyme content	High	Intermediate/Low	Low
Anaerobic enzyme content	Low	High	High
Capillary density	High	Intermediate	Low
Myoglobin content	High	Low	Low
Mitochondria size / density	High	Intermediate	Low
Fiber diameter	Small	Intermediate	Large
Color	Red	White/red	White

## The relative proportion of different types of muscle fibers in different sports

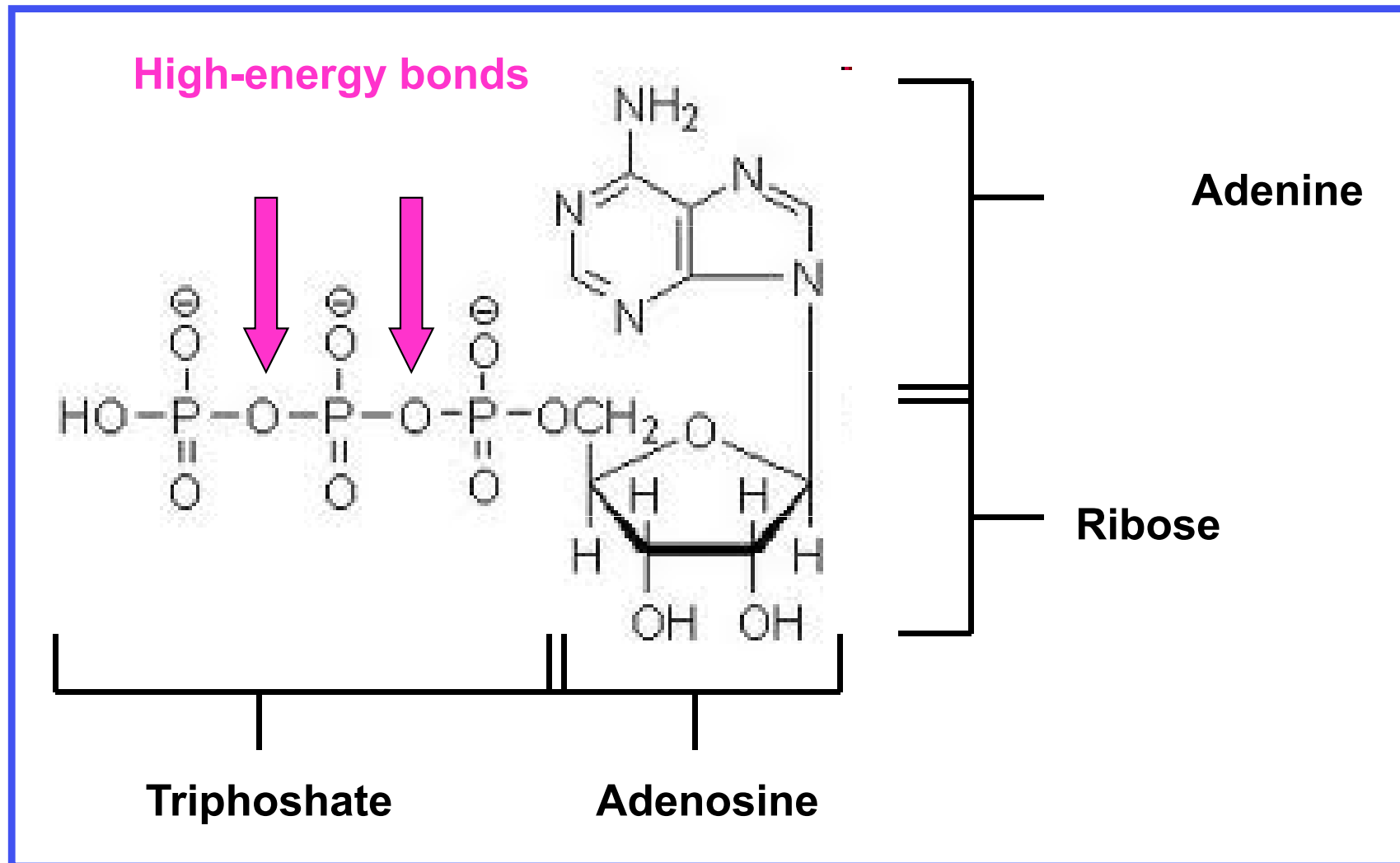
<b>Event</b>	<b>Type I</b>	<b>Type II</b>
100 m sprint	Low	High
800 m run	High	High
Marathon	High	Low
Olympic weightlifting	Low	High
Soccer, hockey	High	High
Basketball	Low	High
Distance cycling	High	Low
Baseball pitcher	Low	High
Boxing	High	High
Cross-country skiing	High	Low
Tennis	High	High

# Bioenergetics

Essential terminology:

- **Bioenergetics** or the flow of energy in a biological system, concerns primarily the conversion of macronutrients-carbohydrates, proteins and fats, which contain chemical energy.
- **Energy** emerges with the decomposition of high-energy bonds in such macronutrients which release energy needed to carry out mechanic work.
- **Catabolism** is the breakdown of large molecules into smaller molecules, associated with the release of energy (e.g. breakdown of glycogen into glucose).
- **Anabolism** is opposite of catabolism. It is the synthesis of larger molecules from smaller molecules (e.g. synthesis of proteins from amino acids).

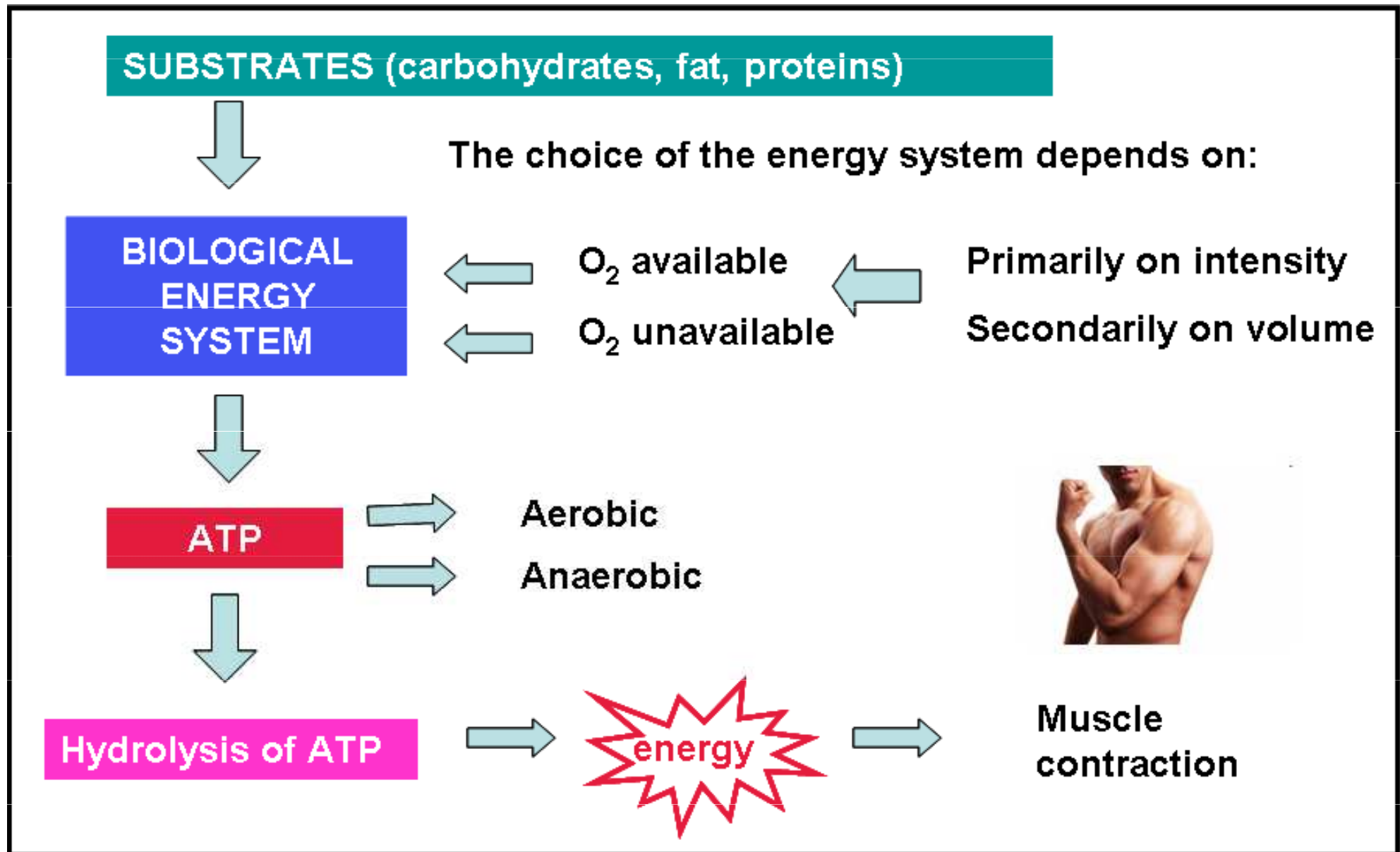
# Adenosine triphosphate (ATP)



- The only possible,, fuel,, of skeletal muscle



# Flow of energy in a biological system



**low**

**intensity**

**high**

**aerobic**

**How?**

**anaerobic**

**Mitochondria**

**Where?**

**Sarcoplasm**

**Carbohydrates**

**substrate**

**Carbohydrates**

**Fats**

**(Proteins)**

**Energy  
system**

**Slow  
glycolysis**

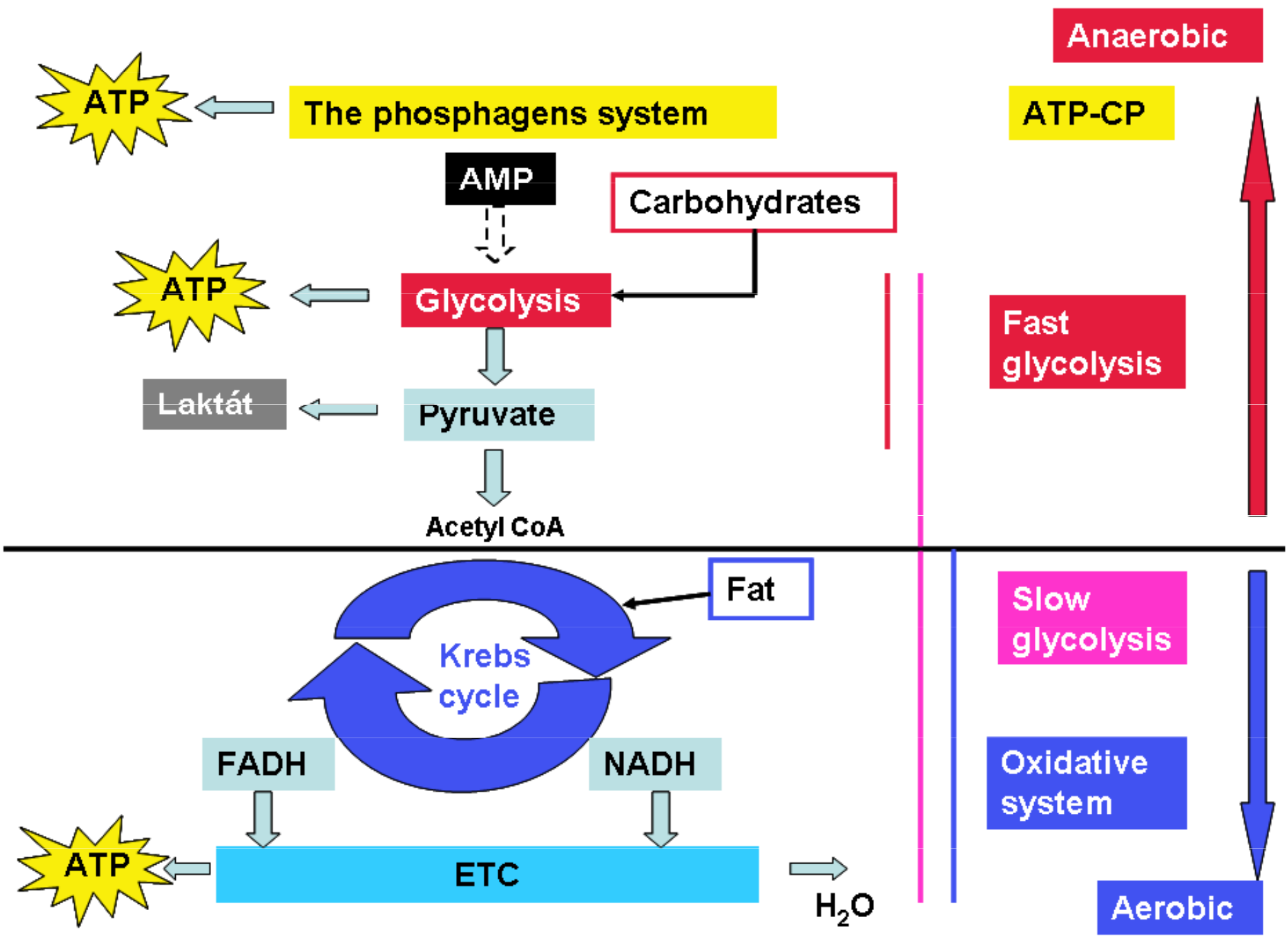
**Fast glycolysis**

**Oxidative  
system**

**ATP-CP  
system  
(phosphagen)**

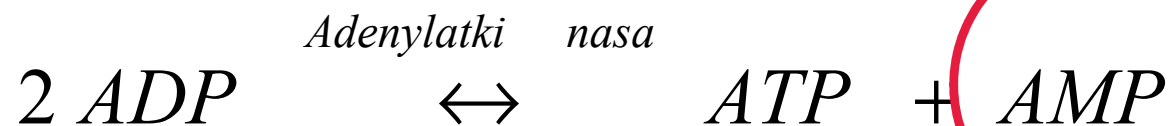
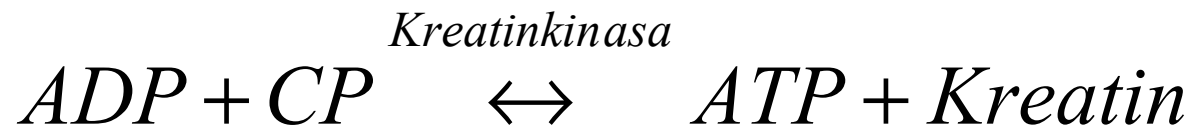
# Energy systems

- **Phosphagen (ATP-CP)**
- **Fast glycolysis (LA)**
- **Slow glycolysis ( $O_2$ )\***
- **Oxidative system ( $O_2$ )**



# Phosphagen system (ATP-CP)

The **phosphagen system** provides ATP primarily for short-term, high-intensity activities (e.g., resistance training and sprinting) and **is active at the start of all exercise regardless of intensity.**



# Glycolysis

**Glycolysis is the breakdowns of carbohydrates-either glycogen stored in the muscle and in the liver or glucose delivered in the blood-to resynthesize ATP.**

Pyruvate is the end result of glycolysis, may proceed in one of two directions:

- 1. Pyruvate can be converted to lactate**
- 2. Pyruvate can be shuttled into the mitochondria**

# Oxidative system

The **oxidative system**, the primary source of ATP at rest and during low-intensity activities, uses primarily carbohydrates and fats as substrates.

Following the onset of activity, as the intensity of exercise increases, there is a shift in substrate preference from fats to carbohydrates.

# Creation of energy, capacity

- Creating ATP through the above energy systems differs in its ability to supply energy for activities of different intensity and duration.
- In general, there is an inverse relationship between a given energy system's maximum rate of ATP production (i.e., ATP produced per unit of time) and the total amount of ATP it is capable of producing over a long time.
- As a result, **the phosphagen energy system** primarily supplies ATP for high-intensity activities of short duration (e.g., 100 m dash), **the glycolytic system** for moderate to high intensity activities of short to medium duration (e.g., 400m dash), and **the oxidative system** for low intensity activities of long duration (e.g., marathon).
- The extent to which each of the three energy systems contributes to ATP production depends **primarily on the intensity** of muscular activity and **secondarily on duration**. At no time, during either exercise or rest does any single energy system provide the complete supply of energy.



## Effect of Event Duration and Intensity on Primary Energy System Used

Duration of event	Intensity of event	Primary energy system(s)
<b>0-6 seconds</b>	Extremely high	<b>Phosphagen</b>
<b>6-30 seconds</b>	Very high	<b>Phosphagen and fast glycolysis</b>
<b>30 second to 2 minutes</b>	High	<b>Fast glycolysis</b>
<b>2-3 minutes</b>	Moderate	<b>Fast glycolysis and oxidative system</b>
<b>&gt;3 minutes</b>	<b>Low</b>	<b>Oxidative system</b>

## Rankings of Rate and Capacity of ATP Production

System	Rate of ATP production	Capacity of ATP production
Phosphagen	1	5
Fast glycolysis	2	4
Slow glycolysis	3	3
Oxidation of carbohydrates	4	2
Oxidation of fats and proteins	5	1

Note: 1 = fastest/greatest; 5 = slowest/least



MINISTERSTVO ŠKOLSTVÍ,  
MLÁDEŽE A TĚLOVÝCHOVY



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Thank you for your attention