



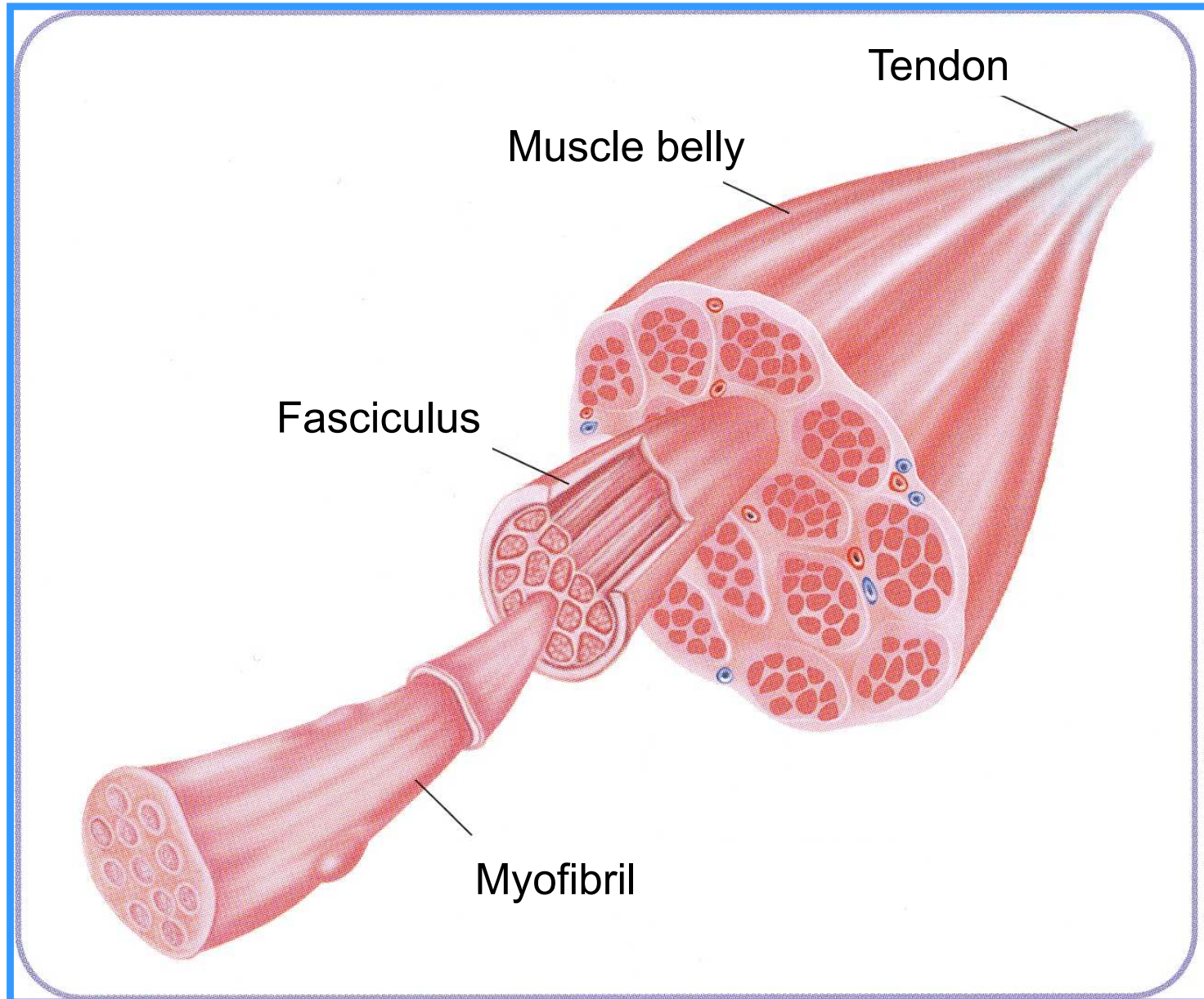
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

SECURING ENERGY FOR SPORTS PERFORMANCE

David Zahradník, PhD.

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

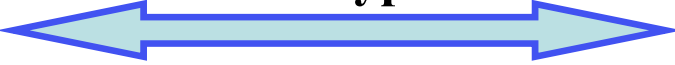


Suitable for activities with high loading rate



Low anaerobic performance

fast

	Fiber types 		
	slow		fast
Characteristic	Type I	Type IIa	Type IIx
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

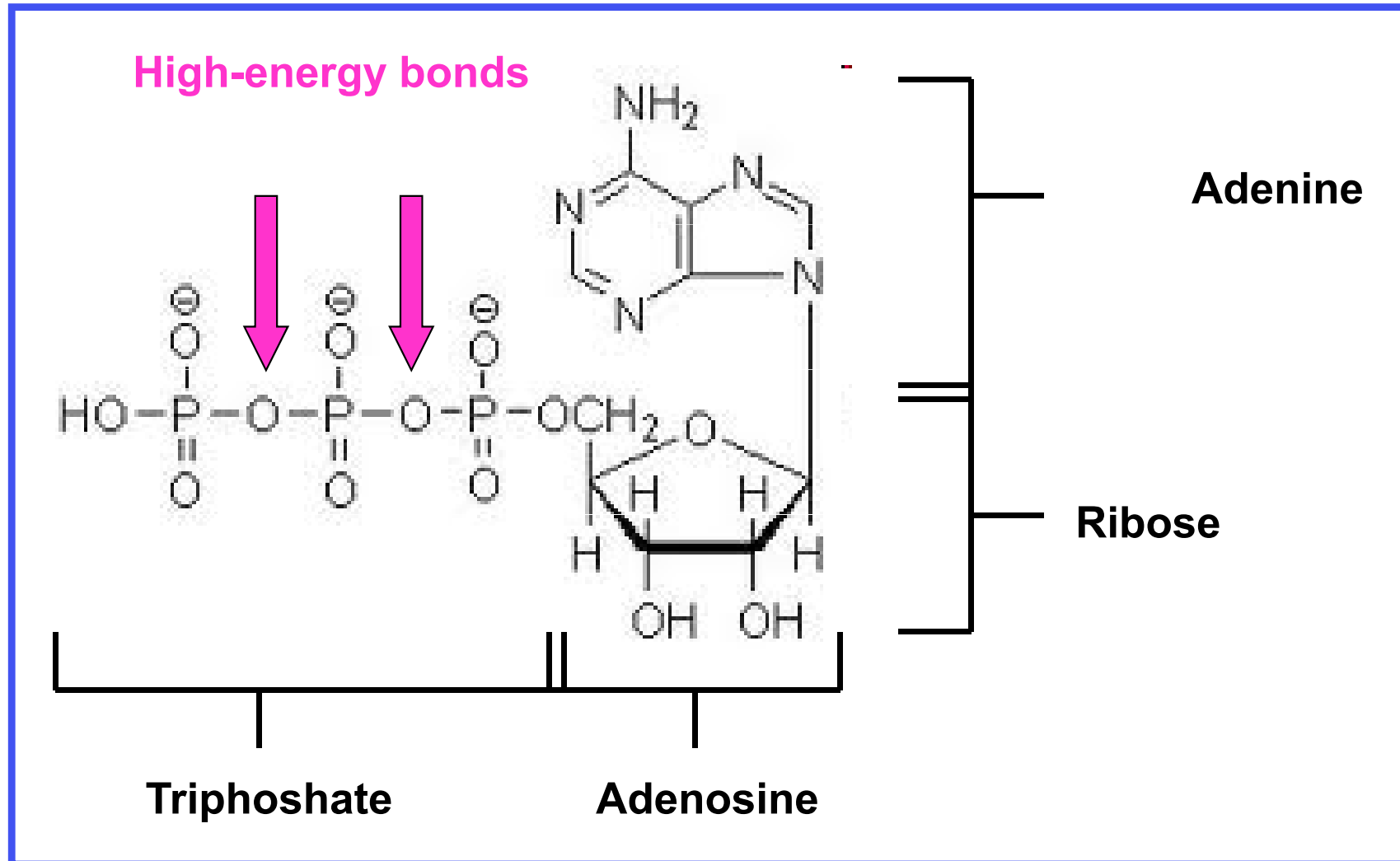
Event	Type I	Type II
100 m sprint	Low	High
800 m run	High	High
Marathon	High	Low
Olympic weightlifting	Low	High
Soccer, hockey	High	High
Basketball	Low	High
Distance cycling	High	Low
Baseball pitcher	Low	High
Boxing	High	High
Cross-country skiing	High	Low
Tennis	High	High

Bioenergetics

Essential terminology:

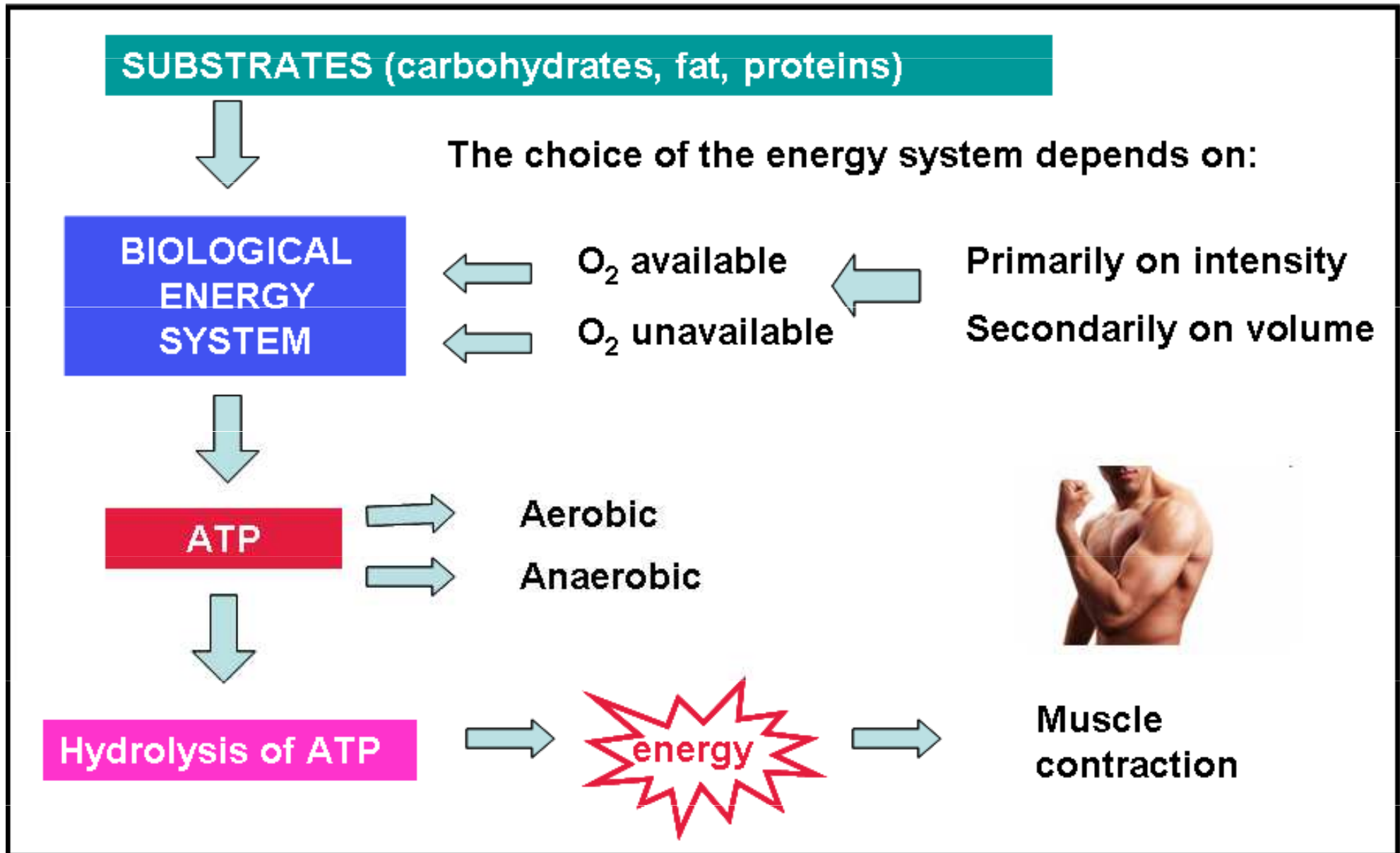
- **Bioenergetics** or the flow of energy in a biological system, concerns primarily the conversion of macronutrients-carbohydrates, proteins and fats, which contain chemical energy.
- **Energy** emerges with the decomposition of high-energy bonds in such macronutrients which release energy needed to 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**

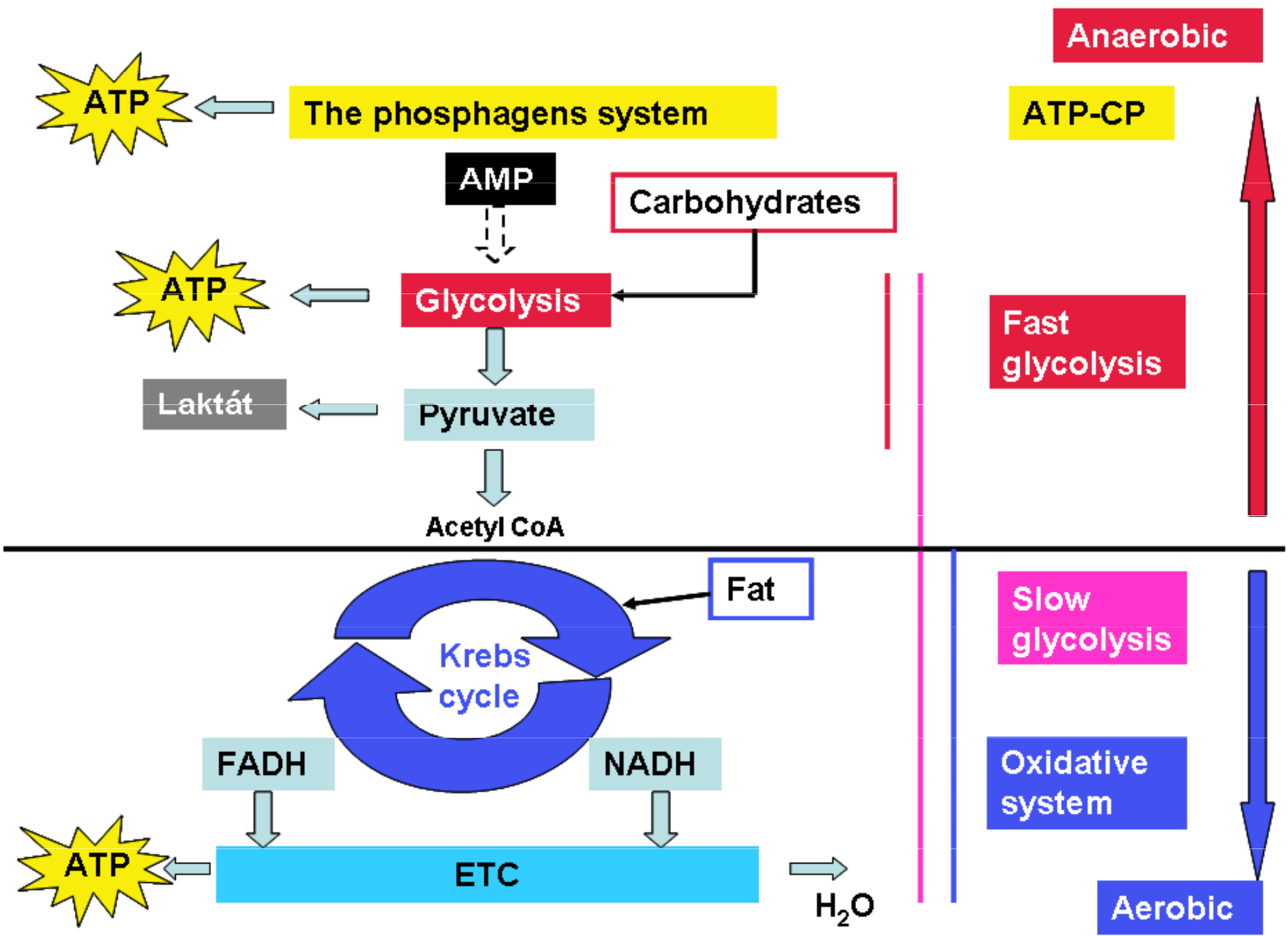
Fast glycolysis

**Oxidative
system**

**ATP-CP
system
(phosphagen)**

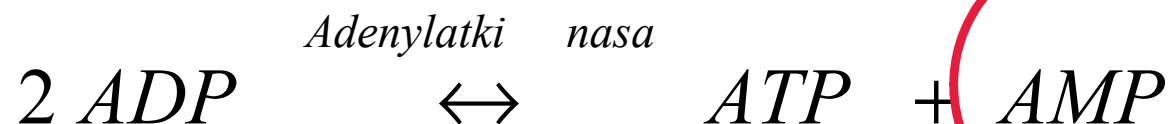
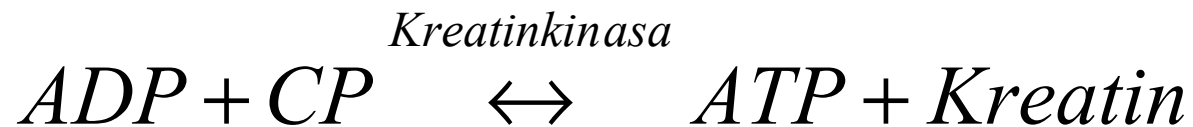
Energy systems

- **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 system 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)
0-6 seconds	Extremely high	Phosphagen
6-30 seconds	Very high	Phosphagen and fast glycolysis
30 second to 2 minutes	High	Fast glycolysis
2-3 minutes	Moderate	Fast glycolysis and oxidative system
>3 minutes	Low	Oxidative system

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



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Thank you for your attention