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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

SECURING ENERGY FOR SPORTS PERFORMANCE

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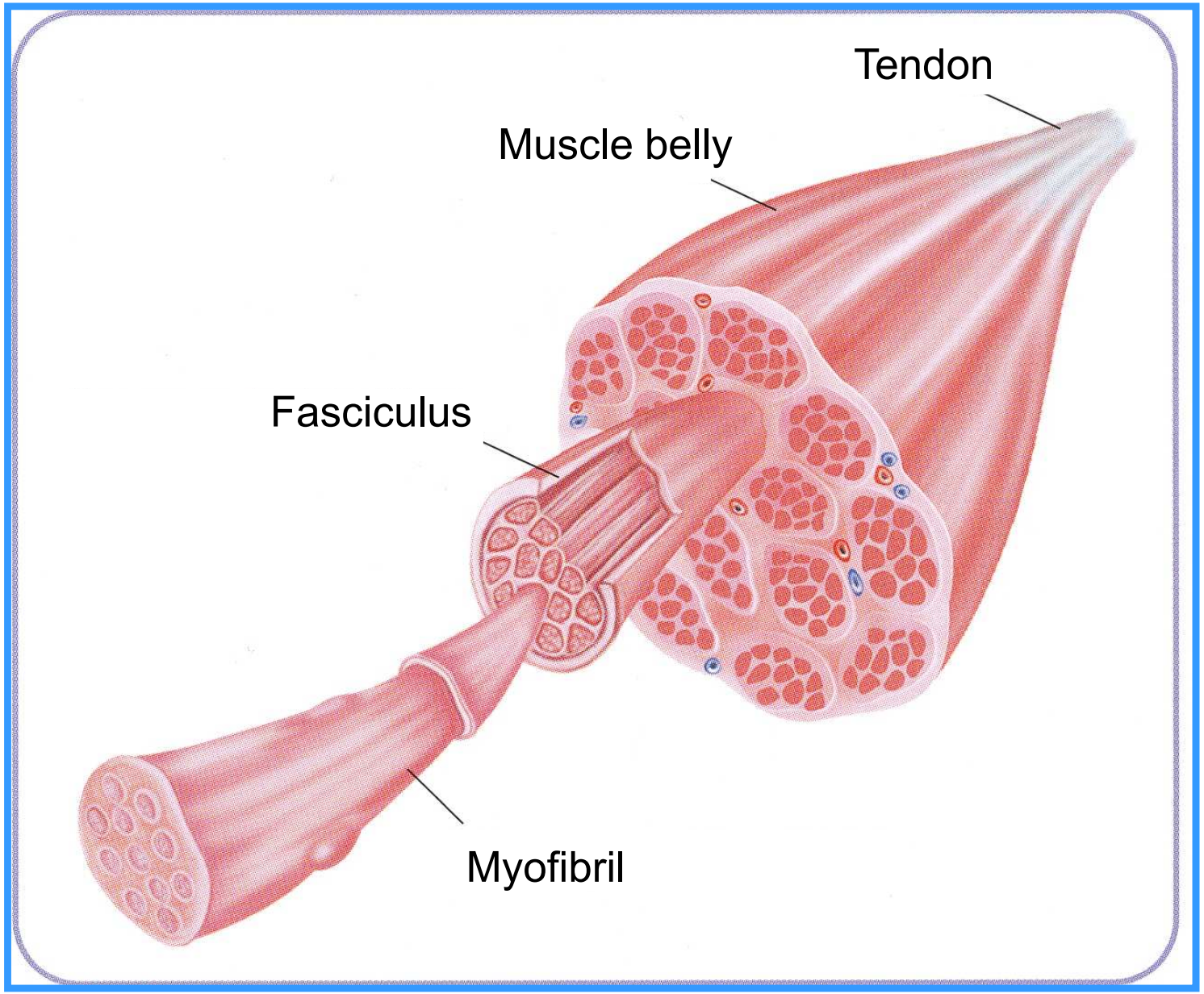
Muscle fiber



Type of muscle fibers

Key criteria for the classification of types of muscle fibers:

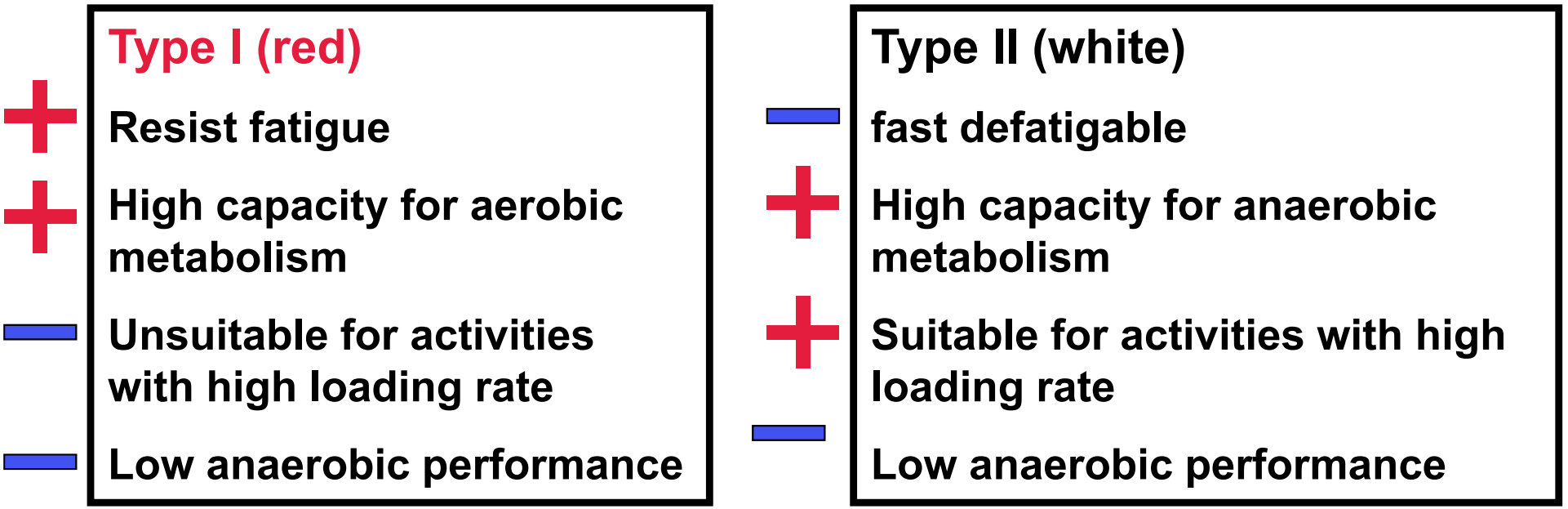
1. Ability to supply sufficient energy for muscle contraction

2. Ability to resist fatigue

We distinguish:

Red **White**	**or**	**Type I.** **Type IIa, IIx**

Basis characteristics



	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

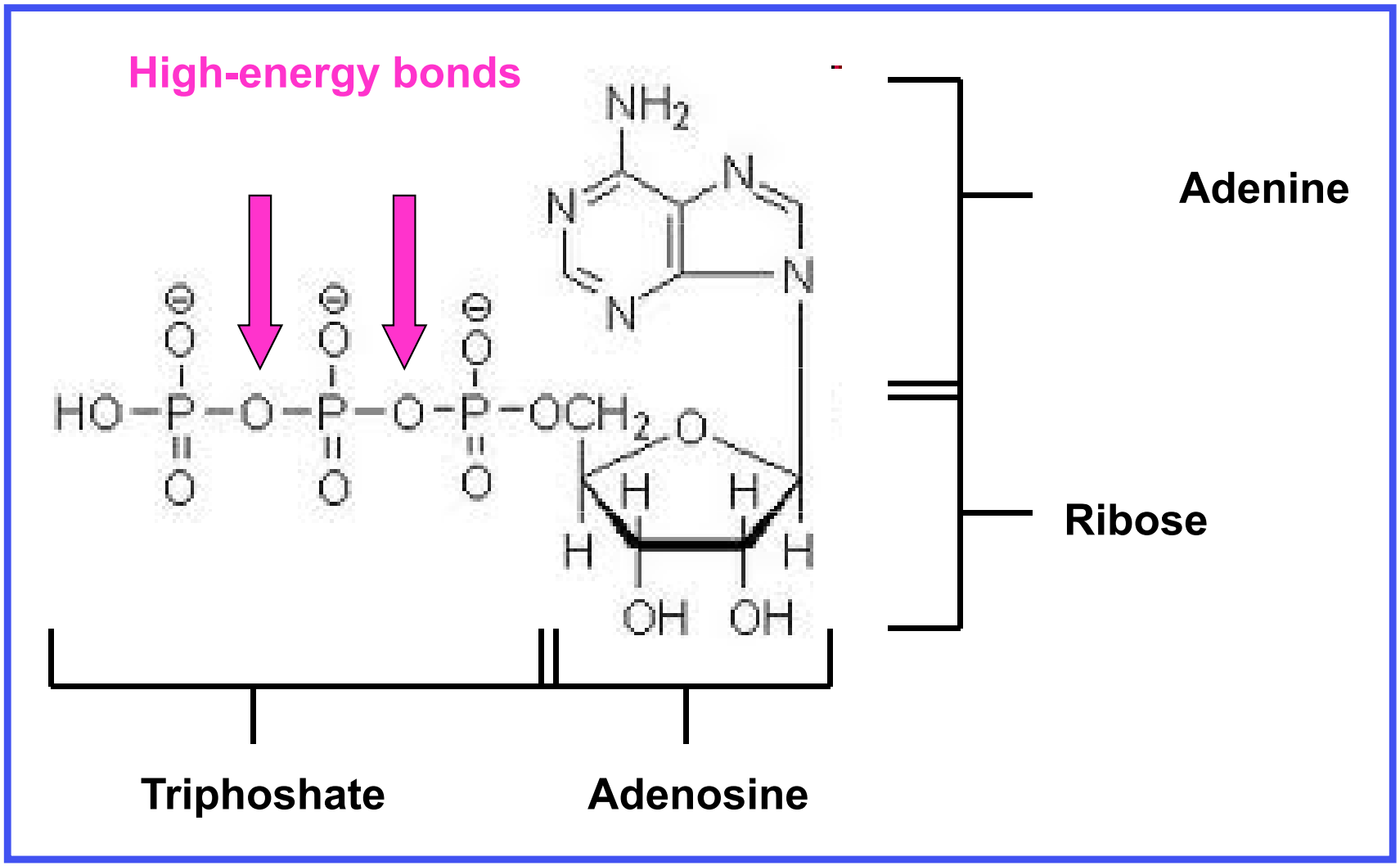
Event	Type I	Type II
100 m sprint	Low	High
800 m run	High	High
Marathon	High	Low
Olympic weightlifting	Low	High
Soccer, hockey	High	High
Basketball	Low	High
Distance cycling	High	Low
Baseball pitcher	Low	High
Boxing	High	High
Cross-country skiing	High	Low
Tennis	High	High

Bioenergetics

Essential terminology:

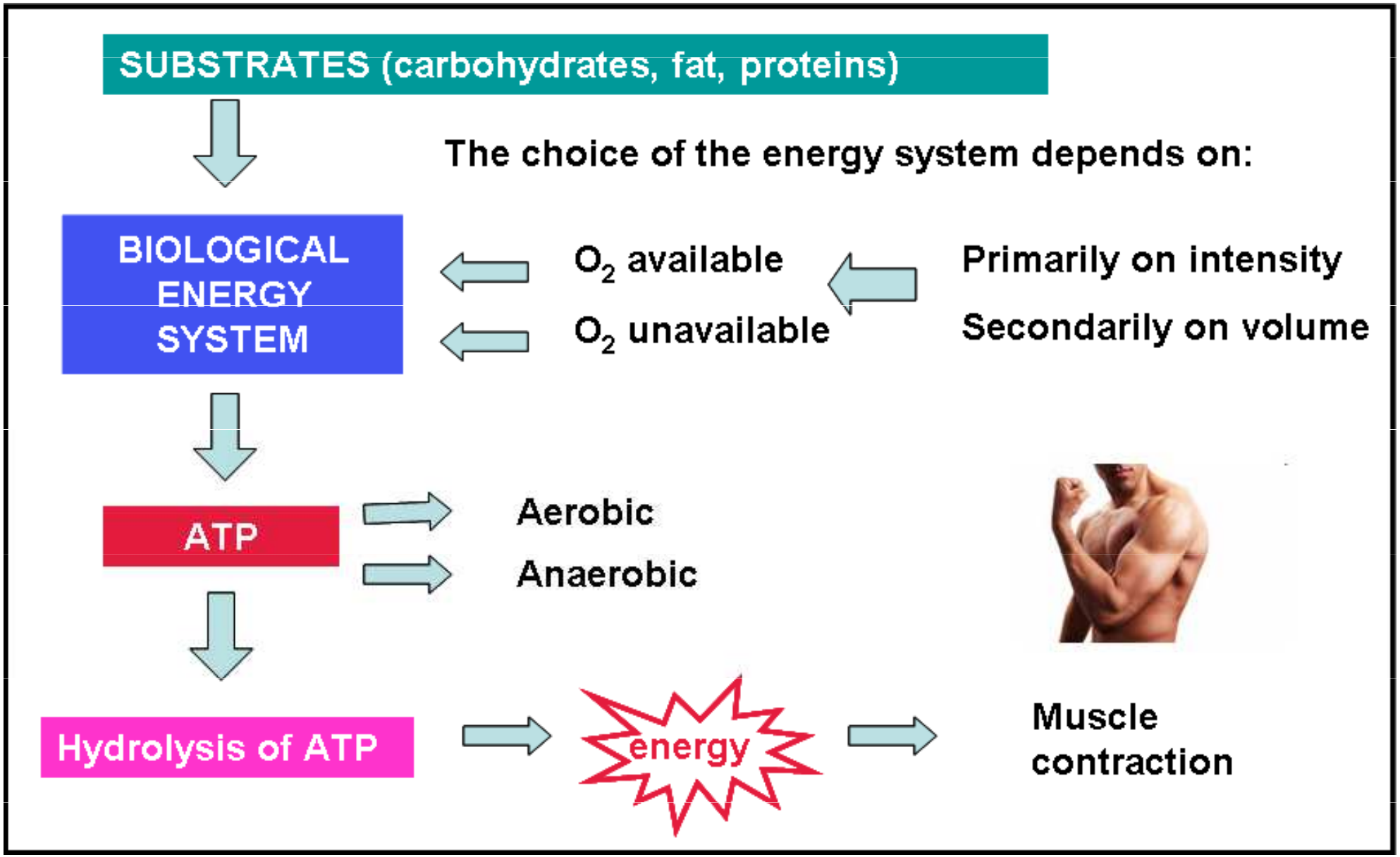
- **Bioenergetics** or the flow of energy in a biological system, concerns primarily the conversion of macronutrients-carbohydrates, proteins and fats, which contain chemical energy.
- **Energy** emerges with the decomposition of high-energy bonds in such macronutrients which release energy needed to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

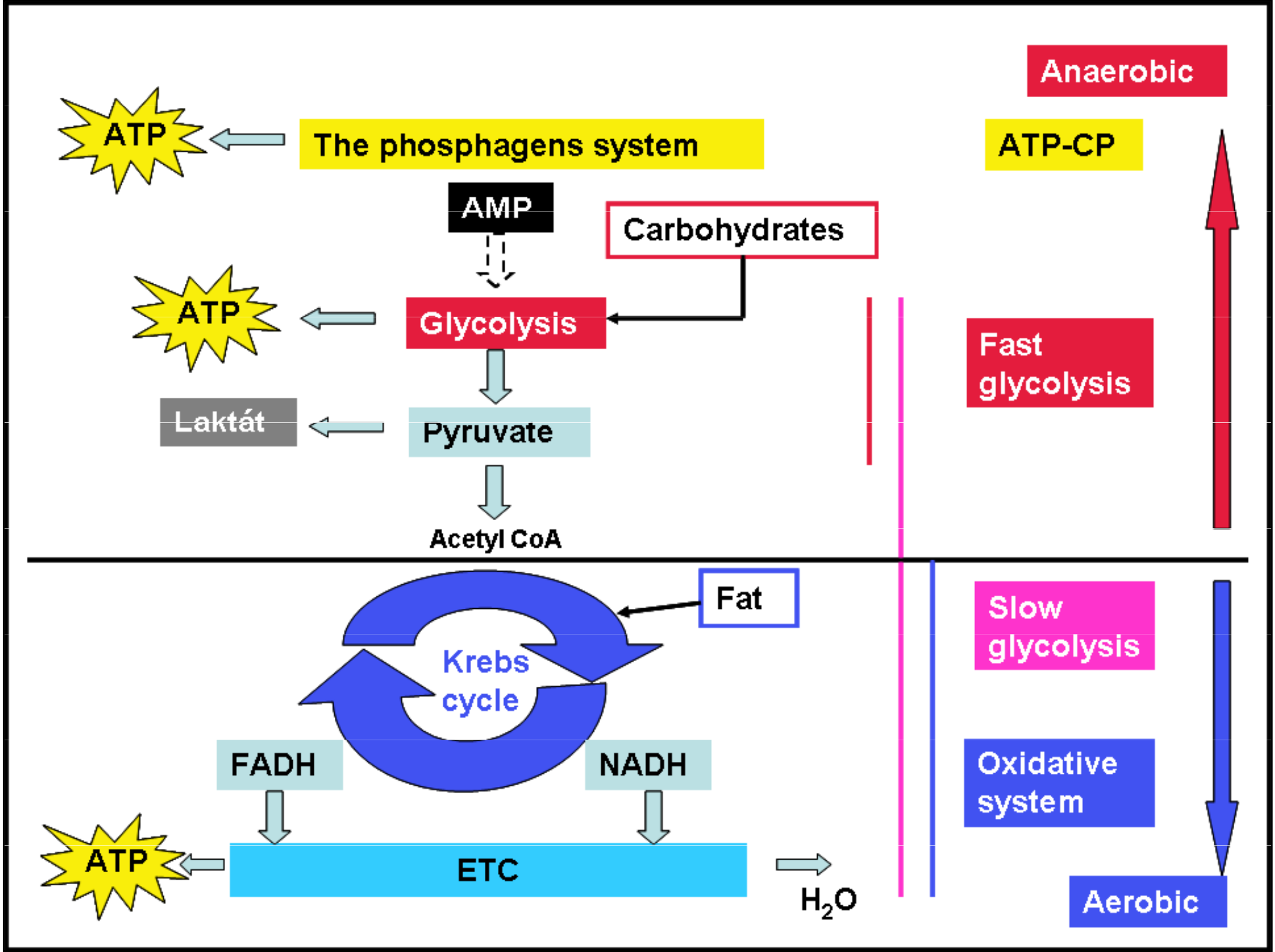
Flow of energy in a biological system



low	intensity	high
aerobic	How?	anaerobic
Mitochondria	Where?	Sarcoplasm
Carbohydrates Fats (Proteins)	substrate	Carbohydrates
Slow glycolysis Oxidative system	Energy system	Fast glycolysis ATP-CP system (phosphagen)

Energy systems

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


Anaerobic
ATP
The phosphagens system
ATP-CP
AMP
Carbohydrates
ATP
Glycolysis
Fast glycolysis
Laktát
Pyruvate
Acetyl CoA
Fat
Slow glycolysis
Krebs cycle
FADH
NADH
Oxidative system
ATP
ETC
H_2O
Aerobic

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.**

$$ADP + CP \xrightarrow{Kreatinkinasa} ATP + Kreatin$$

$$2\ ADP \xrightarrow{Adenylatkinasa} ATP + AMP$$

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 extend 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

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Thank you for your attention