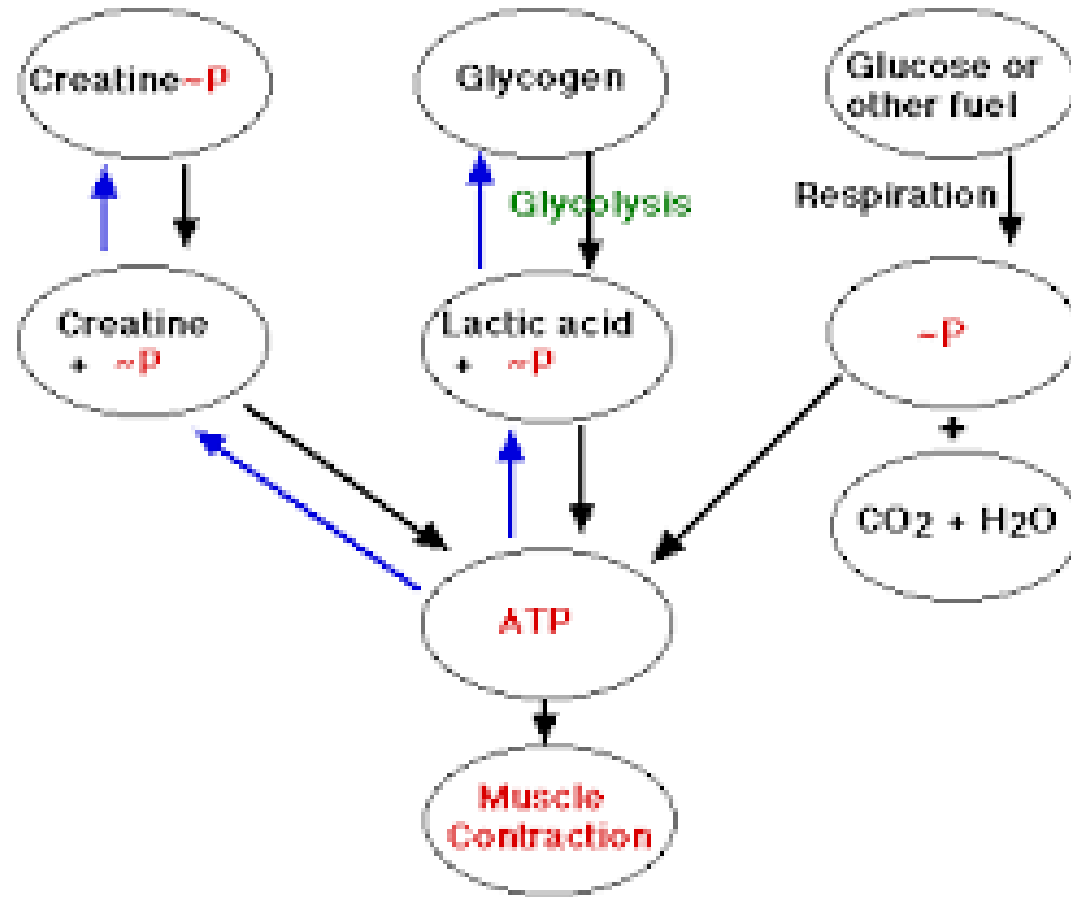
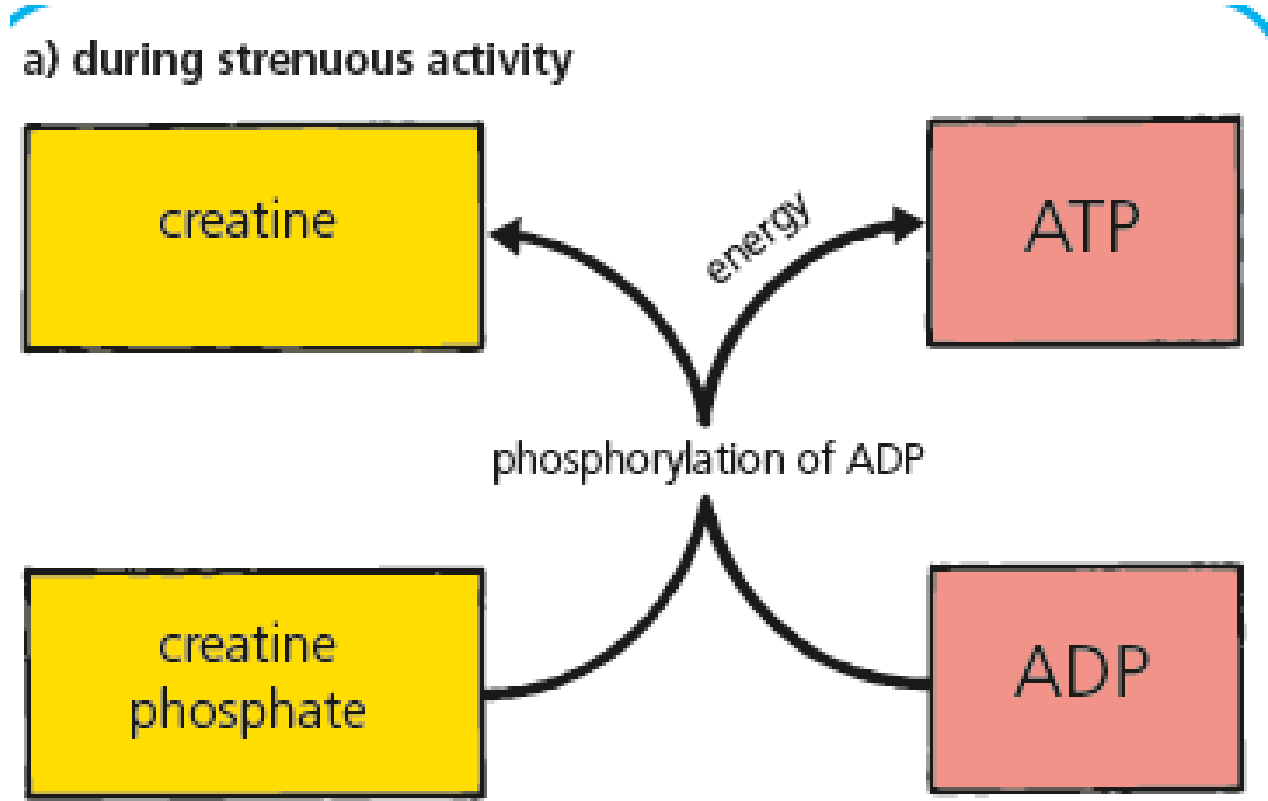


Energy systems in muscle cells



I can describe the role of creatine phosphate

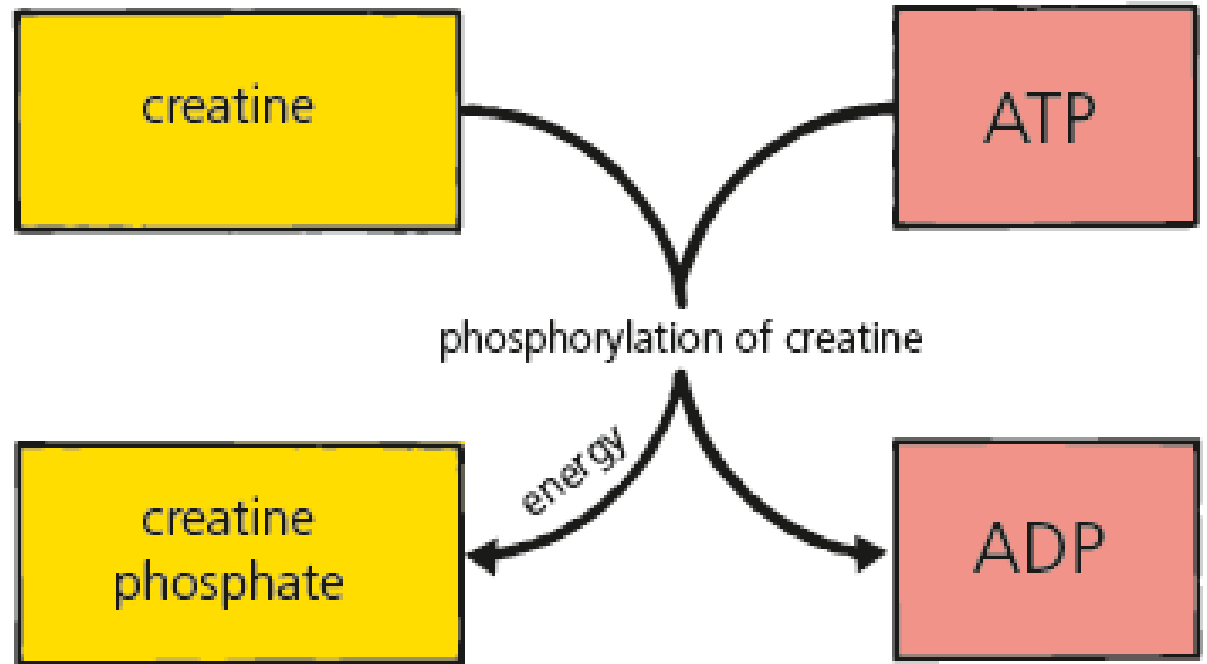
During strenuous muscle activity the cell rapidly breaks down its reserves of ATP to release energy. Muscle cells have an additional source of energy in **creatine phosphate** which can replenish ATP pools for around 10 seconds.



I can describe the role of creatine phosphate

When muscle energy demands are low, Creatine phosphate is regenerated using ATP from cellular respiration. It is a **high energy reserve**.

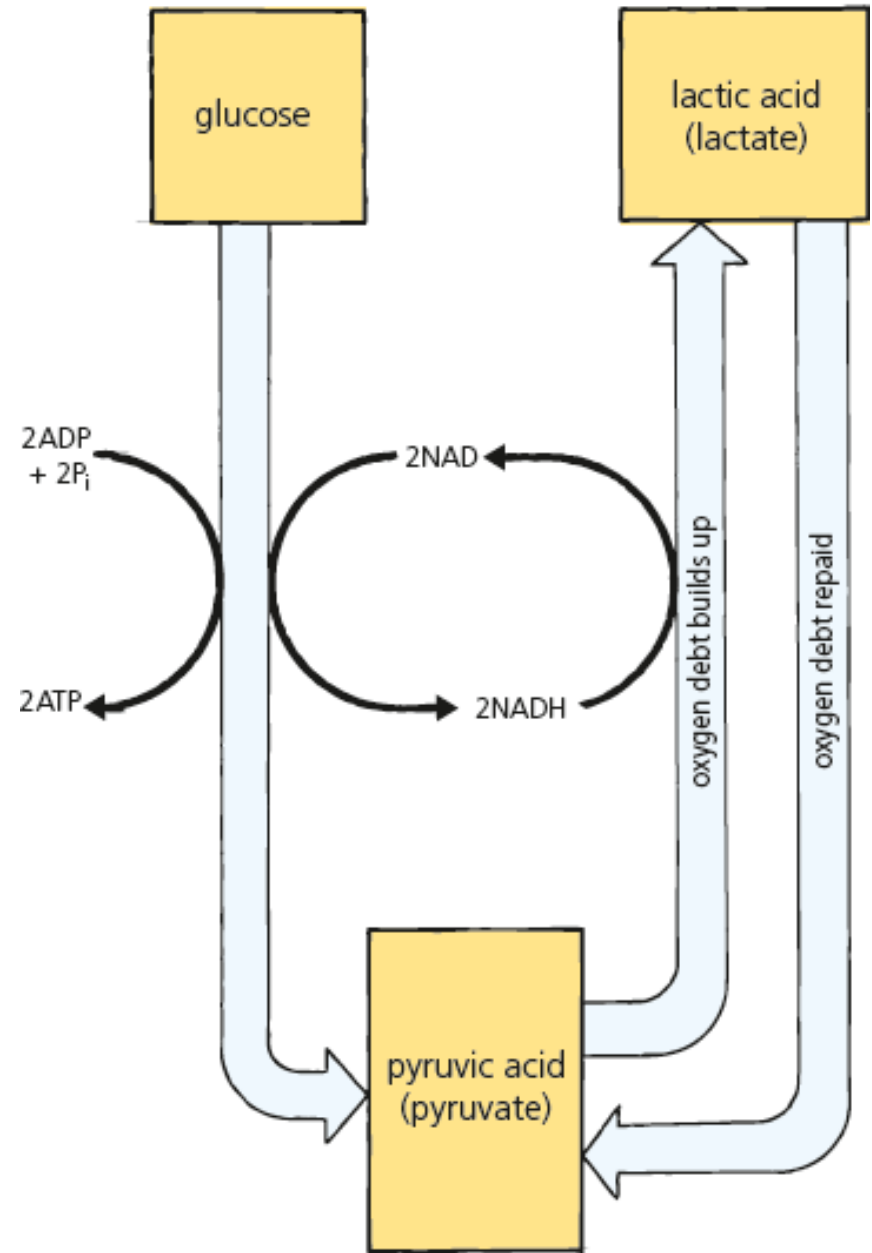
b) during rest period



L.I. Energy systems in muscle cells

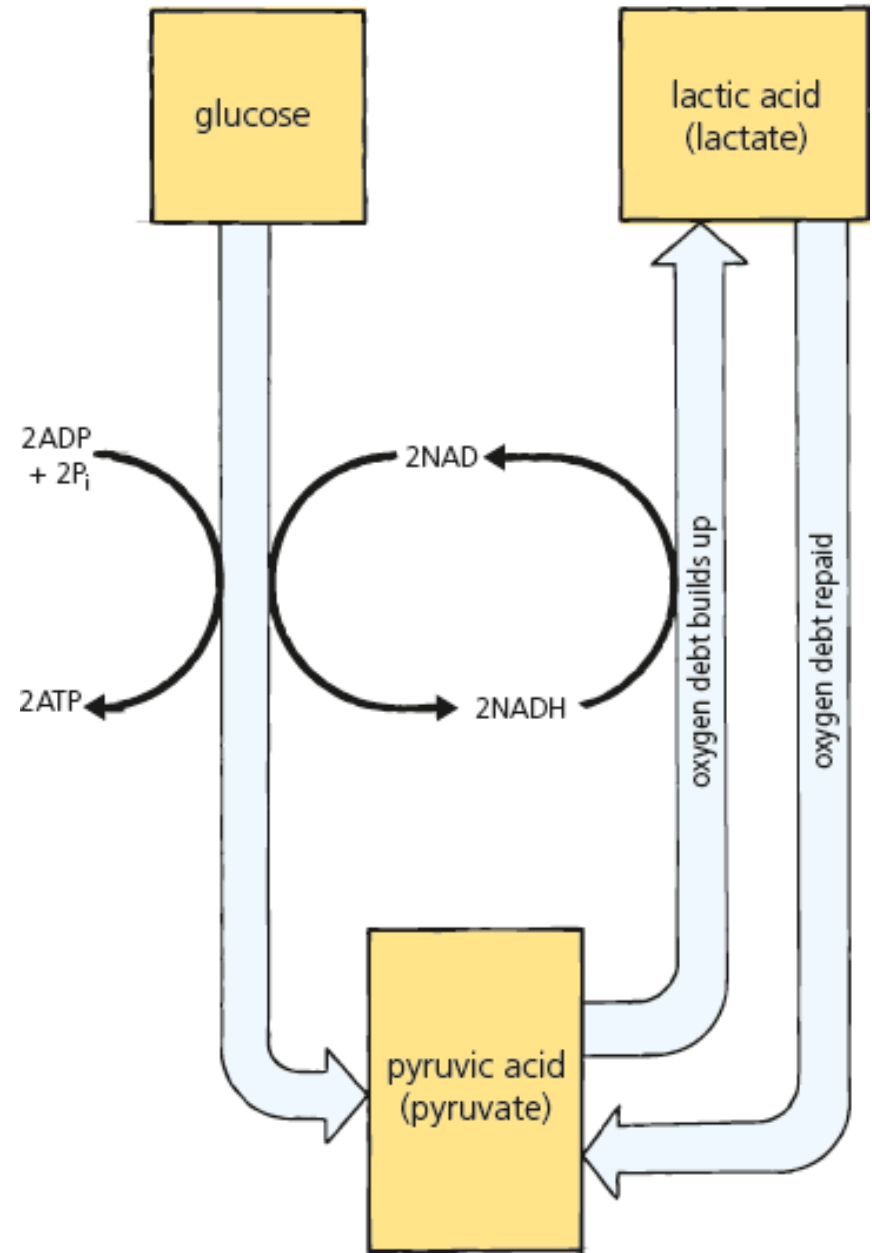
I can describe lactic acid metabolism

- During vigorous exercise, the muscle cells do not get sufficient oxygen to support the electron transport chain. Pyruvate is converted to **lactic acid**.
- Hydrogen from the NADH produced during glycolysis to pyruvic acid is used to produce lactic acid.
- This generates the NAD needed to maintain ATP production through glycolysis.



I can describe lactic acid metabolism

- Lactic acid accumulates in muscle causing **fatigue**.
- **Oxygen debt** repaid when exercise is complete allows respiration to provide the energy to convert lactic acid back to pyruvic acid.
- Only **2ATP** produced per molecule of glucose.



Muscle Metabolism: Energy for Contraction

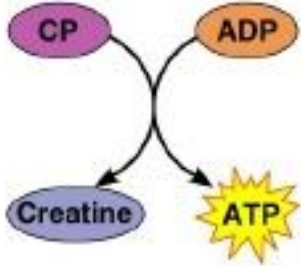
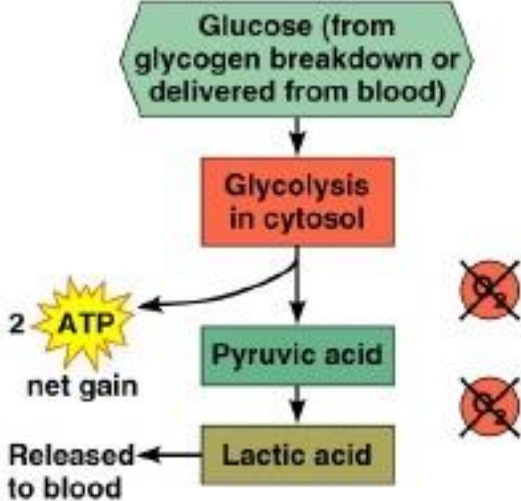
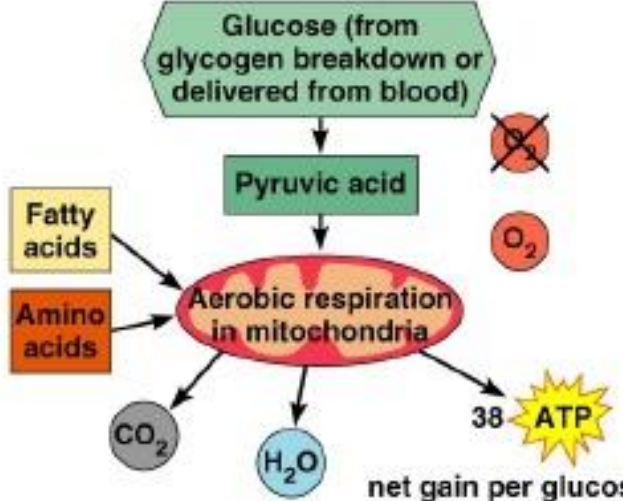
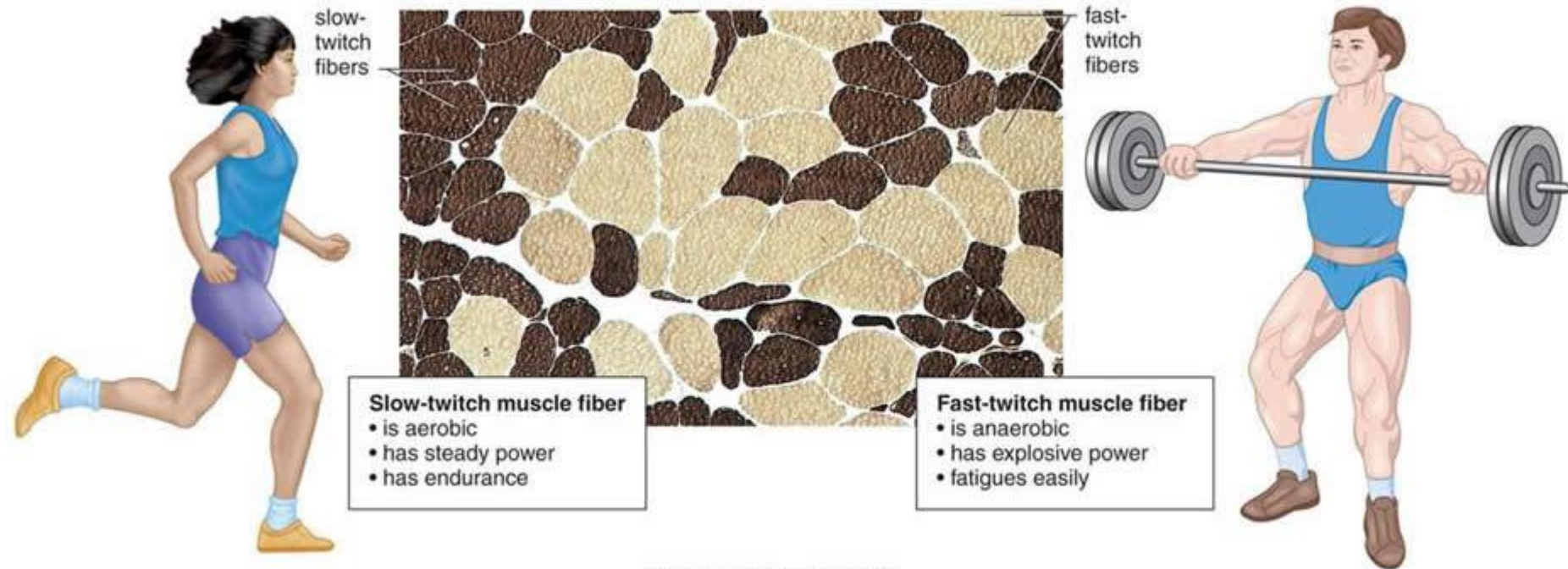
 <p>Diagram (a) illustrates the direct phosphorylation pathway. It shows a cycle where Creatine Phosphate (CP) is converted to Creatine, and Adenosine Diphosphate (ADP) is converted to Adenosine Triphosphate (ATP). The ATP is represented by a yellow starburst.</p>	 <p>Diagram (b) illustrates the anaerobic mechanism. Glucose (from glycogen breakdown or delivered from blood) enters the cytosol and undergoes glycolysis to produce Pyruvic acid. This process yields a net gain of 2 ATP. Pyruvic acid can be converted to Lactic acid, which is then released to the blood. Red 'X' marks indicate that this pathway does not require oxygen.</p>	 <p>Diagram (c) illustrates the aerobic mechanism. Glucose (from glycogen breakdown or delivered from blood) is converted to Pyruvic acid. Pyruvic acid, along with Fatty acids and Amino acids, enters the mitochondria for aerobic respiration. This process requires oxygen (O₂) and produces carbon dioxide (CO₂) and water (H₂O). The net gain is 38 ATP per glucose molecule. Red 'X' marks indicate that this pathway requires oxygen.</p>
<p>(a) Direct phosphorylation [coupled reaction of creatine phosphate (CP) and ADP]</p>	<p>(b) Anaerobic mechanism (glycolysis and lactic acid formation)</p>	<p>(c) Aerobic mechanism (aerobic cellular respiration)</p>
<p>Energy source: CP</p>	<p>Energy source: glucose</p>	<p>Energy source: glucose; pyruvic acid; free fatty acids from adipose tissue; amino acids from protein catabolism</p>
<p>Oxygen use: None Products: 1 ATP per CP, creatine Duration of energy provision: 15 s.</p>	<p>Oxygen use: None Products: 2 ATP per glucose, lactic acid Duration of energy provision: 30–60 s.</p>	<p>Oxygen use: Required Products: 38 ATP per glucose, CO₂, H₂O Duration of energy provision: Hours</p>

Figure 9.20

I can describe skeletal muscle fibres

- There are two types of skeletal muscle fibres - **slow twitch** and **fast twitch**



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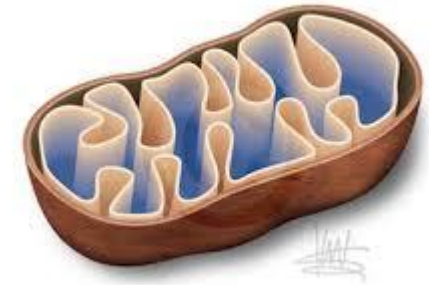
I can describe skeletal muscle fibres

- Slow twitch (type1):
- **Contract more slowly**
- can **sustain contractions for longer**
- good for **endurance activities**



Slow twitch (type1) muscle fibres:

- rely on **aerobic respiration** to generate ATP
- have **many mitochondria**,
- a **large blood supply**
- high concentration of the oxygen storing protein **myoglobin**.
- The major storage fuel of slow twitch muscle fibres is **fats**.



I can describe skeletal muscle fibres

Fast twitch (type1) muscle fibres:

- **contract more quickly, over short periods,**
- **good for bursts of activity**



Fast twitch (type1) muscle fibres:

- **generate ATP through glycolysis only**
- and have **fewer mitochondria and lower blood supply** than slow twitch muscle fibres.
-
- The major storage fuels of fast twitch muscle fibres are **glycogen and creatine phosphate.**