# Heart muscles (HM) must work constantly & rhythmically

- Contain myosin & actin like Skeletal muscles (SM)
- Differs from SM
- HM continuously active
- Regular rhythm of contraction & relaxation
- Sometimes, heart (H) work faster & harder (e.g. when O2 demands increase OR adrenaline stimulates)

Adrenaline: epinephrine, adrenal gland released in stress or excitation

- H – no large range of work output as that of SM
- H – aerobic metabolism at all times
- SM can have anaerobic metabolism (short periods)
- Mitochondria abundant in H than SM (make almost half of cell volume)
- H – Fuels: glucose, FFA, ketone bodies (from blood)
- Fuels oxidized via CAC to get ATP
- SM have glycogen & lipids stored
- H don't have these.
- H – reserve energy stored as phosphocreatine

## Moderately active muscles

- Fuel – FFA, KB, glucose
- Glucose oxidized (glycolysis, CAC)

## Maximally acti ve muscles

- High demand for ATP
- Blood cannot provide $O_2$ & fuel fast
- Stored muscle glycogen used
- Glycogen converted to lactate (anaerobic glycolysis), give ATP also
- Lactate go to liver via blood & converted to glucose (gluconeogenesis)

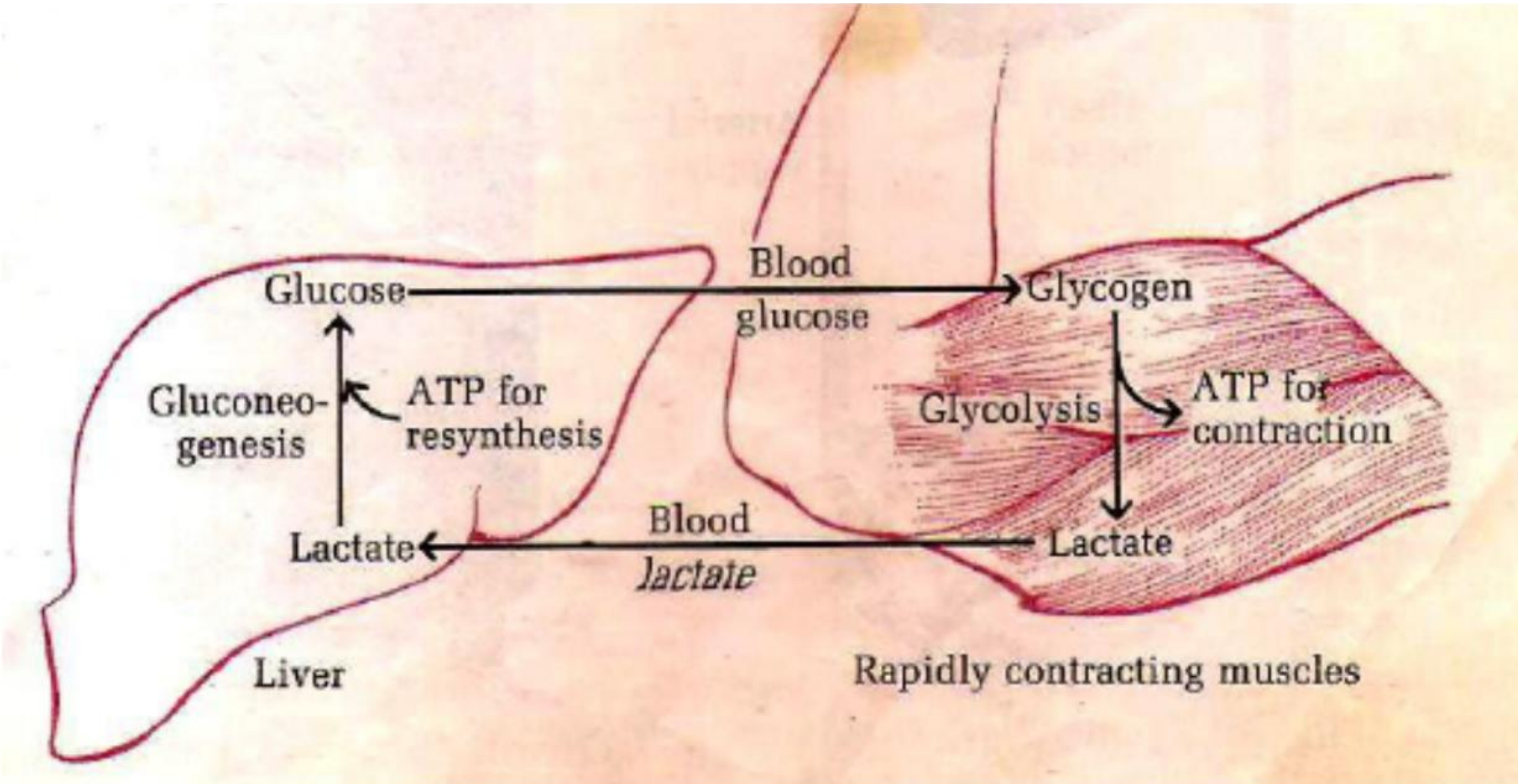


Figure 24-12
*Metabolic cooperation between skeletal muscles and the liver. During extremely active muscular work skeletal muscle uses its glycogen as energy source, via glycolysis. During recovery some of the lactate formed in the muscles is transported to the liver and rebuilt to form blood glucose, which returns to the muscles to replenish their glycogen stores.*

## Role of adrenaline

- Enhance the use of glucose & muscle glycogen as emergency fuel for muscular activity
- Stimulate blood glucose synthesis from glycogen (liver)
- Stimulate glycogen breakdown to lactate (muscles)

Adrenaline or epinephrine: hormone, neurotransmitter, secreted by adrenal glands

## Glucose-6-phosphatase

- Skeletal muscle lack this E
- So, skeletal muscle glycogen - provide energy via glycolytic breakdown

**Glucose 6-phosphatase:** hydrolyzes glucose-6-phosphate, resulting in the creation of a phosphate group and free glucose. This catalysis completes the final step in gluconeogenesis and glycogenolysis and therefore plays a key role in the homeostatic regulation of blood glucose levels

- Skeletal muscles - Limited glycogen storage
- So, limited glycolytic energy available

- Skeletal muscles becomes less efficient due to:

  -lactic acids production

  -low pH

  -rising temp.

Recovery period-fast breathing (athletes) give extra O2

- $O_2$ oxidize pyruvate, lactate & other fuels to produce ATP & phosphocreatine in muscles
- Extra $O_2$ in fast breathing restores normal metabolic state
- In restoration, liver & muscles cooperate

# Phosphocreatine (PC)

- ✓ Another way to get ATP in emergency
- ✓ Muscles have PC

$$\text{Phosphocreatine} + \text{ADP} \overset{Mg^{2+}}{\rightleftharpoons} \text{creatine} + \text{ATP}$$

- ✓ Give ATP as reaction goes to right during muscle contraction
- ✓ PC resynthesized during recovery period

# Muscle contraction (MC)

- Requires ATP
- MC initiated by motor nerve impulse, transmitted to transverse tubules & sarcoplasmic reticulum (SR)
- SR release $Ca^{2+}$
- $Ca^{2+}$ binds to troponin (a regulatory protein)
- Troponin translates signal into actin filament sliding (using ATP)

# Muscle relaxation (MR)

- $Ca^{2+}$ sequestered for MR
- $Ca^{2+}$ Transported back to SR by $Ca^{2+}$-transporting membrane ATPase
- 2 $Ca^{2+}$ for 1 ATP hydrolyzed
- Same ATP consumption in MC & MR