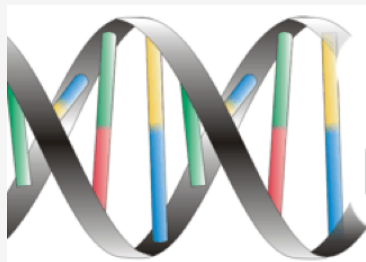


# MUSCULOSKELETAL BLOCK

Aerobic and anaerobic metabolism

Lecture 2 male, lecture 3 female

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**433**  
Biochemistry  
Team

**Color index:**

Red= important

Purple = addition

Orange = Explanation

# Objectives:

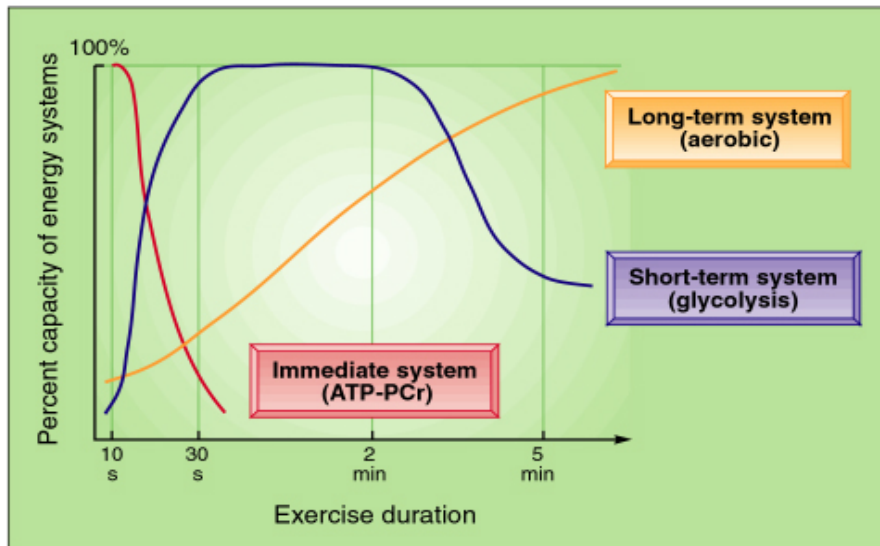
- **Three systems of energy transfer**
- **ATP as energy source**
- **Aerobic metabolism: red muscle fibers**
- **Anaerobic metabolism: white muscle fibers**
- **Cori cycle**
- **Glucose-alanine cycle**
- **Muscle fatigue and endurance in athletes**

# Abbreviations

- **PCr = Phosphocreatine**
- **ATP = Adenosine triphosphate**
- **ADP = Adenosine diphosphate**
- **TCA cycle = Tricarboxylic acid**

## Three systems of energy transfer

	Long-term system	Short-term system	Immediate-system
Type of metabolism	Aerobic	Anaerobic (glycolysis)	Anaerobic (ATP-PCr)
Source	Fatty acid	Glucose	Phosphatocreatine (PCr)
Type of exercise	Continuous exercise	High intensity exercise	High intensity exercise
Duration	Hours	15 sec to 2 min	3-15 sec



## ATP as a source of energy

**ATP:** The nucleotide coenzyme **adenosine triphosphate (ATP)** is the most important form of chemical energy stored in cells.

### How does it release energy?

Breakdown of **ATP** into **ADP+PO<sub>4</sub>** releases energy

### Which of function it used for?

This energy is used for all body functions (**biosynthesis, membrane transport, muscle contraction, etc.**)

### What is the main pathway for ATP synthesis?

The main pathway for ATP synthesis is **oxidative phosphorylation** catalyzed by the **respiratory chain**

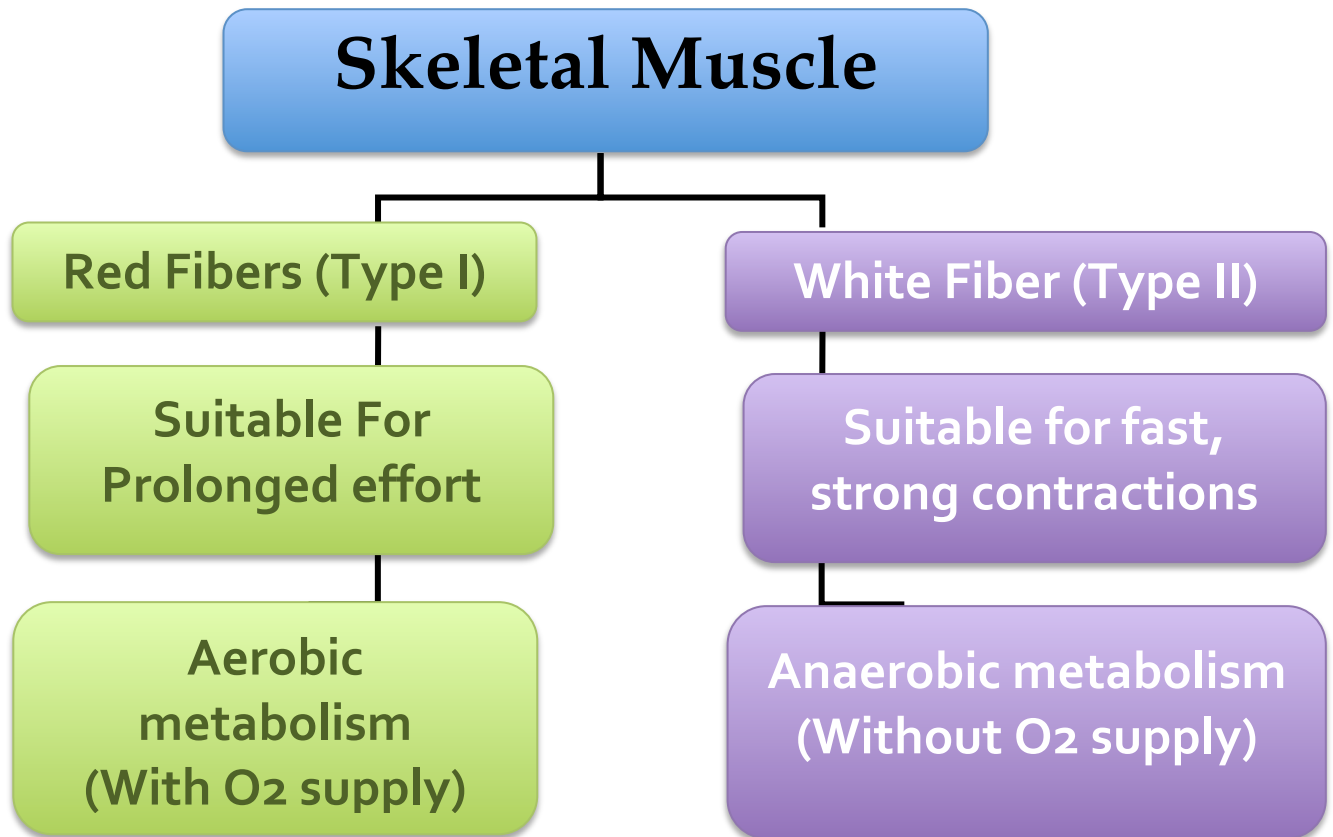
### What is the name of enzyme that catalyzes ATP synthesis?

**ATP synthase**

### How can we form a new ATP?



## Energy metabolism in muscle



### Please Note that:

- ❖ Muscle contraction requires **high level of ATP** consumption
- ❖ Without constant resynthesis, the amount of ATP is used up in **less than 1 sec. of contraction**

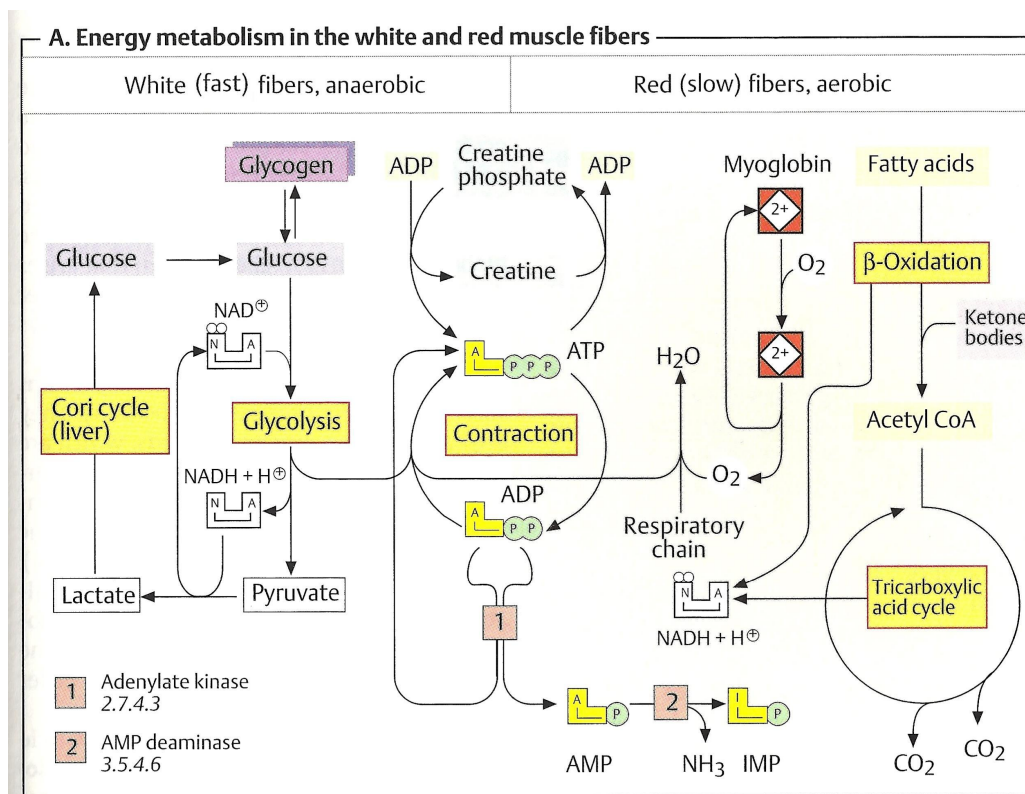
Overview of Energy Metabolism in Skeletal Muscle:  
See it here: <http://goo.gl/hR8H8S>

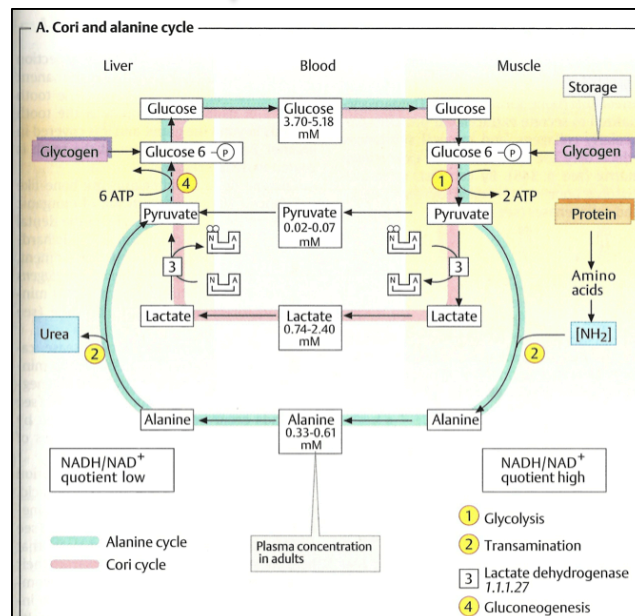
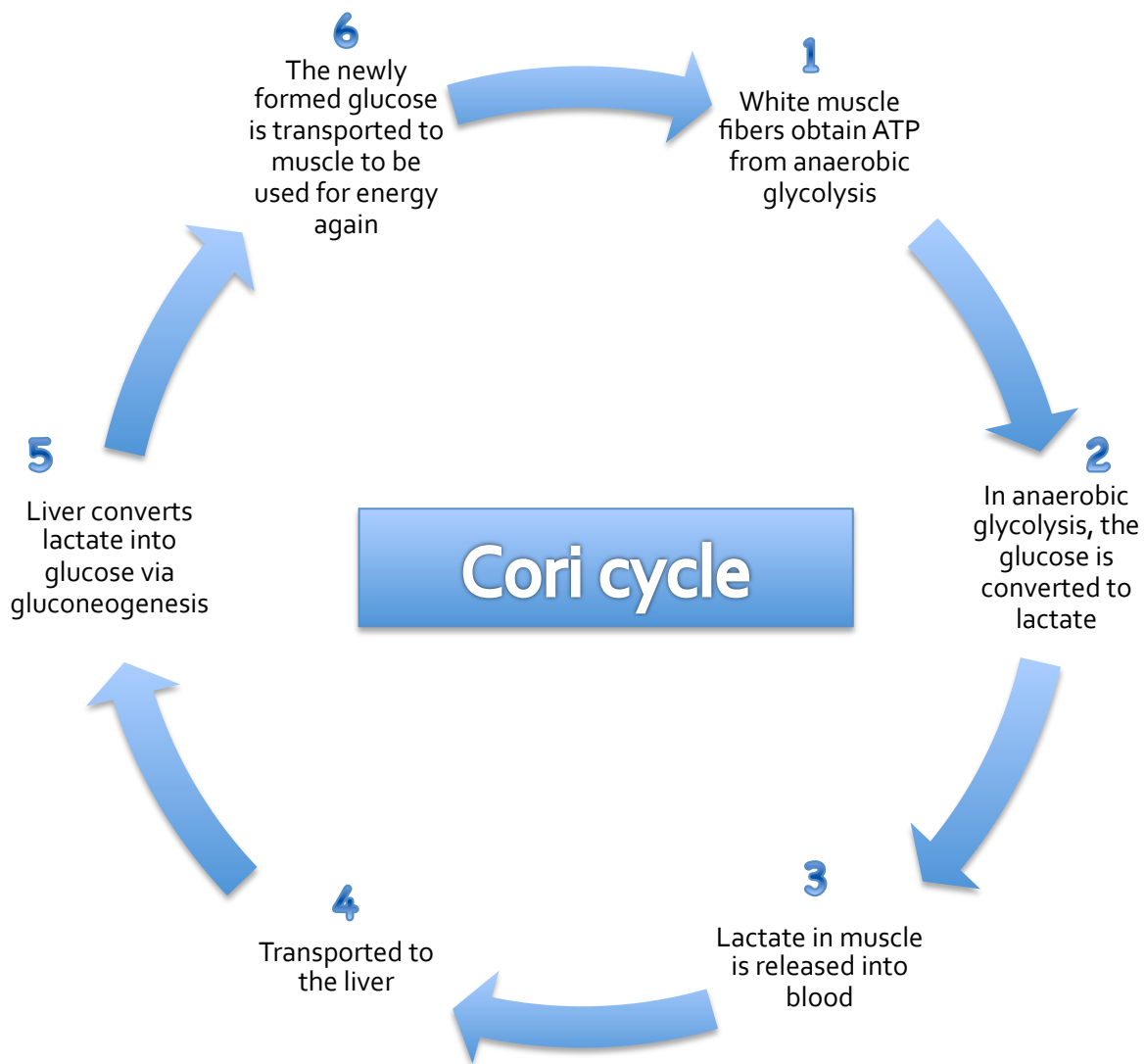
## Aerobic metabolism in Red (Slow) fibers

- Suitable for prolonged effort
- Red fibers obtain their ATP mainly from fatty acids
- Fatty acids are broken down by  $\beta$ -oxidation, TCA cycle, and the respiratory chain
- Red color is due to myoglobin
- Higher  $O_2$  affinity than hemoglobin
- Releases  $O_2$  when  $O_2$  level drops

## Anaerobic metabolism in White (Fast) fibers

- Suitable for fast, strong contractions
- During intense muscle activity (weightlifting, etc.)  $O_2$  supply from blood quickly drops
- White fibers mainly obtain ATP from anaerobic glycolysis
- Glycogen  $\rightarrow$  glucose-1- $PO_4 \rightarrow$  glucose-6- $PO_4 \rightarrow$  glycolysis  $\rightarrow$  ATP
- $NADH+H^+$  is reoxidized to maintain glucose degradation and ATP formation
- Lactate is formed and converted to glucose in liver (Cori cycle)

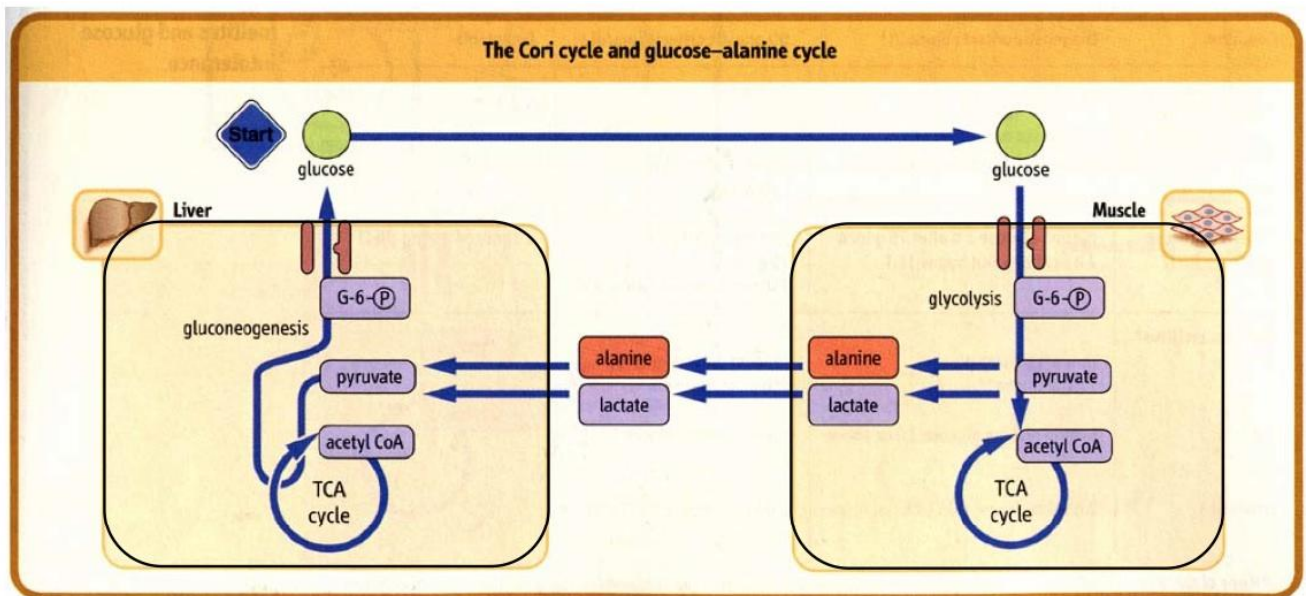
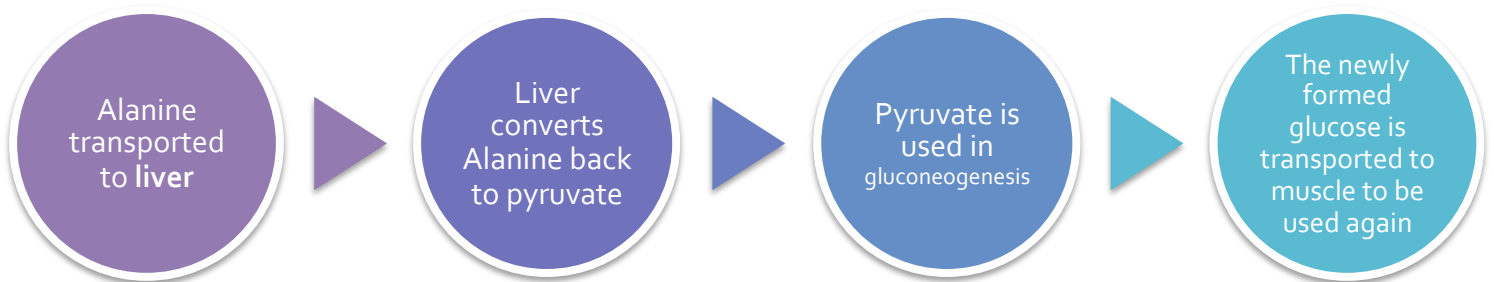
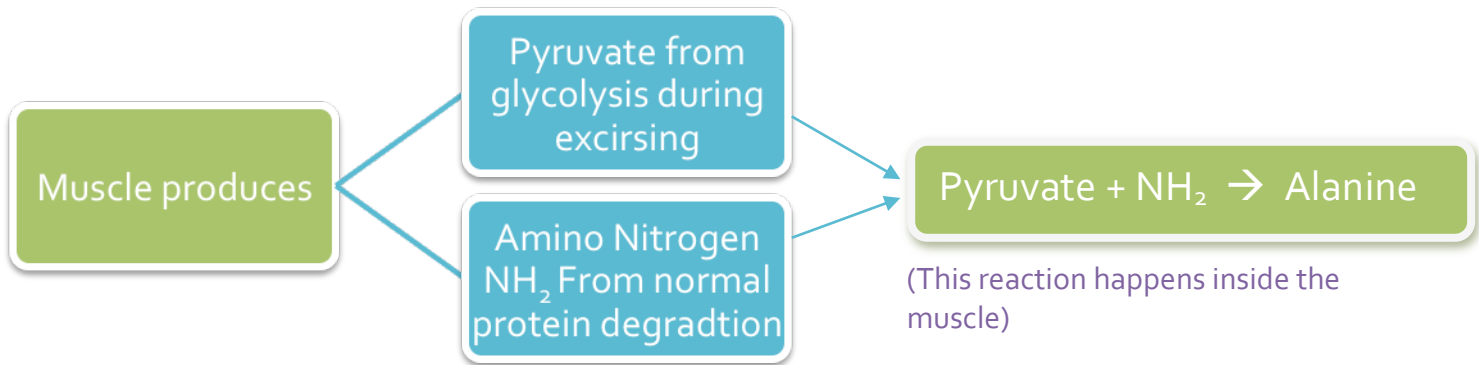




### Why muscle can't produce new glucose from lactate?

Gluconeogenesis requires much more ATP than is supplied by glycolysis in muscle. And O<sub>2</sub> deficiencies do not arise in the liver even during intense exercise. Therefore, liver always has **sufficient ATP for gluconeogenesis**





## Muscle fatigue and endurance in athletes

- **Muscle fatigue:** Inability of muscle to maintain a particular strength of contraction over time.
- **Causes:**
  - Build up of lactic acid (low pH of sarcoplasm)
  - Exhaustions of energy resources ( $\uparrow$  of ADP &  $\downarrow$  Of ATP)
  - Ionic imbalance.
- Athletes are trained to achieve high endurance and delayed fatigue.

## QUIZ YOURSELF

1- which of the following systems is exhausted in a very short period of time of muscle activity?

- a) Anaerobic ATP-PCr
- b) Anerobic glycolysis
- c) Aerobic TCA cycle

2- The enzyme that makes ATP:

- a) ATPase
- b) ATP synthase

3- What is the fiber type used in a strong contraction?

- a) Type I
- b) Red
- c) Both
- d) White

4- Which fuel source does type I depend on?

- a) Carbohydrates
- b) Amino acid
- c) Protein
- d) Fat

5- Alanine consists of

- a) Pyruvate +  $\text{NO}_2$
- b) Pyruvate +  $\text{NH}_2$

ANSWERS:

- 1- A
- 2- B
- 3- D
- 4- D
- 5- B



**GOOD LUCK** From our team members:

**Sara alDokhayel**

Maha AlRajhi

Layan AlTaweel

Maram AlAqil

Amjad AlBatili

Lamees alMezaini

Ghada AlHindi

**Ahmed Alhussien**

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