Heart Rate Training Benefits

- **How the Body Creates Energy for Exercise**
- **1. ATP (Adenosine Triphosphate):**
  - The immediate source of energy used by muscles during contraction.
  - Muscles store a small amount of ATP, which is quickly depleted during activity.

  - **2. Main Energy Production Systems:**
  - **a. ATP-CP System (Phosphagen System)**
  - **Source:** Stored ATP and creatine phosphate (CP) within muscles
  - **Function:** Provides rapid energy for very short, high-intensity efforts (up to ~10 seconds)
  - **Features:**
    - Fastest energy source
    - No oxygen required (anaerobic)
    - Quickly depletes during intense effort

- **b. Glycolytic System (Anaerobic Glycolysis)**
  - **Source:** Glucose from blood or glycogen stored in muscles
  - **Function:** Supports high-intensity efforts lasting from ~10 seconds to 2 minutes

- **Features:**
  - Produces ATP quickly
  - Does not require oxygen (anaerobic)
  - Produces lactate as a byproduct, contributing to muscle fatigue

- **c. Oxidative System (Aerobic Metabolism)**
- **Source:** Carbohydrates, fats, and sometimes proteins
- **Function:** Provides energy for prolonged, lower-intensity exercise (beyond 2 minutes)
- **Features:**
    - Slow to produce ATP
    - Requires oxygen (aerobic)
    - Generates large amounts of ATP
    - Produces carbon dioxide and water as waste

- **3. Which System Dominates?**
- **Short, explosive efforts (sprints, jumps):** ATP-CP and glycolytic systems
- **Endurance and long-duration efforts (marathon, cycling):** Primarily the oxidative system

- **Zone 1: Very Light**
- **Primary adaptations:** Enhances overall recovery, promotes blood flow to muscles, and aids in waste removal.
- **Physiological effects:** Increases capillary density, which improves oxygen delivery; boosts mitochondrial activity, supporting efficient energy production.
- **Training benefit:** Ideal for warm-ups, cool-downs, and active recovery days to prevent injury and promote tissue repair.
- **Zone 2: Light**
- **Primary adaptations:** Strengthens the aerobic energy system, enabling the body to burn fat more efficiently.
- **Physiological effects:** Expansion of mitochondrial networks in muscle cells, improved fat oxidation, increased stroke volume, and cardiac output.
- **Training benefit:** Builds a durable aerobic base essential for long-distance endurance, allowing athletes to sustain lower intensities for longer periods with less perceived effort.

- **Zone 3: Moderate**
- **Primary adaptations:** Improves overall cardiovascular efficiency and muscular endurance.
- **Physiological effects:** Enhanced lactate threshold, allowing muscles to perform at higher intensities without accumulating debilitating levels of lactate.
- **Training benefit:** Provides a strong endurance foundation, enabling runners to handle sustained efforts during races while maintaining a steady pace.
- **Zone 4: Hard**
- **Primary adaptations:** Raises anaerobic capacity and lactate tolerance.
- **Physiological effects:** Increased glycolytic enzyme activity, better lactate clearance, and improved buffering capacity.
- **Training benefit:** Develops the ability to sustain faster paces during key race segments, improving race pace efficiency and resilience.
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- **Zone 3: Moderate (70-80% of max HR)**
- **Primary adaptations:** Improves overall cardiovascular efficiency and muscular endurance.
- **Physiological effects:** Enhanced lactate threshold, allowing muscles to perform at higher intensities without accumulating debilitating levels of lactate.
- **Training benefit:** Provides a strong endurance foundation, enabling runners to handle sustained efforts during races while maintaining a steady pace.
- **Zone 4: Hard (80-90% of max HR)**
- **Primary adaptations:** Raises anaerobic capacity and lactate tolerance.
- **Physiological effects:** Increased glycolytic enzyme activity, better lactate clearance, and improved buffering capacity.
- **Training benefit:** Develops the ability to sustain faster paces during key race segments, improving race pace efficiency and resilience.
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Summary of Metabolism for Endurance

- Your speed is a function of your muscles' ATP recycling rate.
- ATP can be produced via aerobic and anaerobic metabolic process
- Anaerobic and aerobic ATP output combine to meet energy demands
- The aerobic pathway dominates at lower-intensity, long duration exercise
- The anaerobic pathway should be mainly used for high intensity
- The anaerobic ATP production is limited in quanity and duration by the accumulation of pyruvate/lactate.
- ADS

Two Metabolic Pathways

Anaerobic – no oxygen, glycolysis (carbs)

- In the cytosol
- Uses glucose
- Rapidly produces a few ATP and Pyruvate. Pyruvate can enter mitochondria
- Accumulation of Pyruvate in cytosol leads to Lactic Acid (Lactate and H+)
- Limited stores <2000Kcal

Aerobic – oxidative (either fat or carbs)

- Pyruvate or Fat move into mitochondria to enter Krebs cycle
- Produces many ATP
- No pyruvate production thus no Lactic Acid/Lactate and H+ accumulation.
- Huge stores >100,000Kcal.

EVOKE ENDURANCE ARTICLES

- Evoke Endurance Drift Test
- Pro and Cons of HR and RPE
- Zone 2 Training

A Rabbit Hole

- https://www.trainingpeaks.com/blog/the-power-and-importance-of-mitochondria/
- https://evokeendurance.com/setting-your-hear-rate-zones/
- https://uphillathlete.com/aerobic-training/uphill-athlete-training-zones-heart-rate-calculator/
- https://evokeendurance.com/our-latest-thinking-on-aerobic-assessment-for-the-mountain-athlete/
- https://uphillathlete.com/aerobic-training/heart-rate-drift/
- https://www.trainingpeaks.com/blog/zone-2-training-for-endurance-athletes/
- https://evokeendurance.com/why-even-ultra-runners-need-speed-work/
- https://uphillathlete.com/aerobic-training/uphill-athlete-training-zones-heart-rate-calculator/
- https://uphillathlete.com/nutrition/fat-adaptation/
- https://evokeendurance.com/aerobic-deficiency-syndrome-ads/
- https://uphillathlete.com/mountain-running/UTMB-five-training-tips/?utm_source=mailchimp&utm_medium=emails&utm_campaign=May312023-newsletter
- https://www.trainingpeaks.com/blog/all-you-need-to-know-about-lt-and-vo2-max/?utm_source=Iterable&utm_medium=email&utm_campaign=campaign_6883669
- https://www.trainingpeaks.com/blog/work-to-rest-ratio-the-benefits-of-40-20-workouts/?utm_source=Iterable&utm_medium=email&utm_campaign=campaign_6883669
- https://www.trainingpeaks.com/blog/what-is-the-best-workout-for-increasing-vo2-max/?utm_campaign=content2023&utm_medium=email&utm_source=newsletter&utm_content=cta&utm_term=20230709_athlete_premium
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