

**chapter**

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chapter

**11**

# Physiology of Physical Activity

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# PHYSIOLOGY OF PHYSICAL ACTIVITY

- ❖ The study of acute (immediate) physiological responses to physical activity and the changes in physiological responses to chronic (repeated over time) physical activity. These illustrate your body's way of meeting the increased demand for oxygen, energy, and temperature regulation associated with physical activity.
- ❖ Exercise physiologists apply principles of biology and chemistry to understand how the body responds to physical activity; this serves as the foundation for conditioning, fitness, and rehabilitation programs.

# WHAT DOES A PHYSIOLOGIST OF PHYSICAL ACTIVITY DO?

- University professors
- Researchers for the military or NASA
- Employees of corporate fitness or hospital-based wellness programs
- Clinical exercise physiologists employed by hospitals in cardiac rehabilitation programs
- Exercise instructors
- Personal trainers
- Strength and conditioning professionals
- Can specialize with a particular population (older adults, children, pulmonary patients)

# GOALS OF PHYSIOLOGY

- 1.** To understand how to enhance physical performance
- 2.** To understand how to improve physical function in particular environments such as a high temperature or high altitude
- 3.** To understand how physical activity and exercise improve health and fitness
- 4.** To understand how exercise can be used in treating and preventing disease and alleviating symptoms of disease
- 5.** To understand adaptations in human anatomy and physiology in response to physical activity

# SPORT AND EXERCISE PHYSIOLOGISTS

- Sport physiologists apply physiological concepts to the training of athletes.
- Clinical exercise physiologists study the role of physical activity in disease management and rehabilitation.

# HISTORY OF PHYSIOLOGY OF

- Early beginnings evolved from physiology
  - Antoine Lavoisier
  - August Krogh (developed 1st cycle ergometer)
  - A.V. Hill
- Early laboratories
  - Harvard Fatigue Lab: D.B. Dill
  - Springfield College: Peter V. Karpovich

# SIGNIFICANT EVENTS SINCE 1950

- 1950s: Morris Coronary Heart Disease study in England; ACSM founded
- 1960s: Biopsy needle; Mexico City Olympics; ***Medicine and Science in Sports***
- 1970s: ACSM certification program; publications
- 1980s: Amenorrhea related to low bone density
- 1990s: NIH and surgeon general's reports

# HEALTH EFFECTS OF MODERATE PHYSICAL

- ✿ Both the National Institutes of Health (NIH; 1995) and the surgeon general (1996) concluded that moderate physical activity is beneficial in reducing the risk of chronic diseases—heart disease, diabetes, hypertension, and colon cancer.
- ✿ See ***Physical Activity and Health: A Report of the Surgeon General*** (<http://www.cdc.gov/nccdphp/sgr/sgr.htm>) and the NIH Web site ([www.nih.gov](http://www.nih.gov); direct link to JAMA article about the report <http://www.ncbi.nlm.nih.gov/pubmed/8667571>).

# RESEARCH METHODS IN PHYSIOLOGY OF PHYSICAL ACTIVITY

- Laboratory
  - Ergometers: treadmills, leg and arm cycles, and swimming flume
  - Oxygen uptake: gas analyzers
  - Body composition: underwater weighing, calipers, and DEXA
  - Biochemical methods: blood samples and muscle biopsies
  - Animal models: mammals that match humans as closely as possible; can control the subject and environment more easily and specifically

# FIGURE 11.2



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# FIGURE 11.3



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# FIGURE 11.4



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# FIGURE 11.5



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# OVERVIEW OF KNOWLEDGE IN PHYSIOLOGY OF PHYSICAL ACTIVITY

- How physiological systems respond and adapt to physical activity (single and repeated bouts)
- Factors that influence physiological responses (e.g., temperature, diet, and altitude)
- The relationship among fitness, activity, and health

# SKELETAL MUSCLES

- Muscle fiber types (fast and slow twitch)
- Energy sources (page 306)
  - ATP-phosphocreatine system (initial 10-15 seconds of exercise)
  - Anaerobic glycolytic system (initial 1-2 minutes of high-intensity exercise)
  - Aerobic system (prolonged, continuous, light- and moderate-intensity activities)
- Adaptations
  - To anaerobic and aerobic training
  - To resistance training
- Training principles
  - Progressive overload and specificity

# FIGURE 11.6

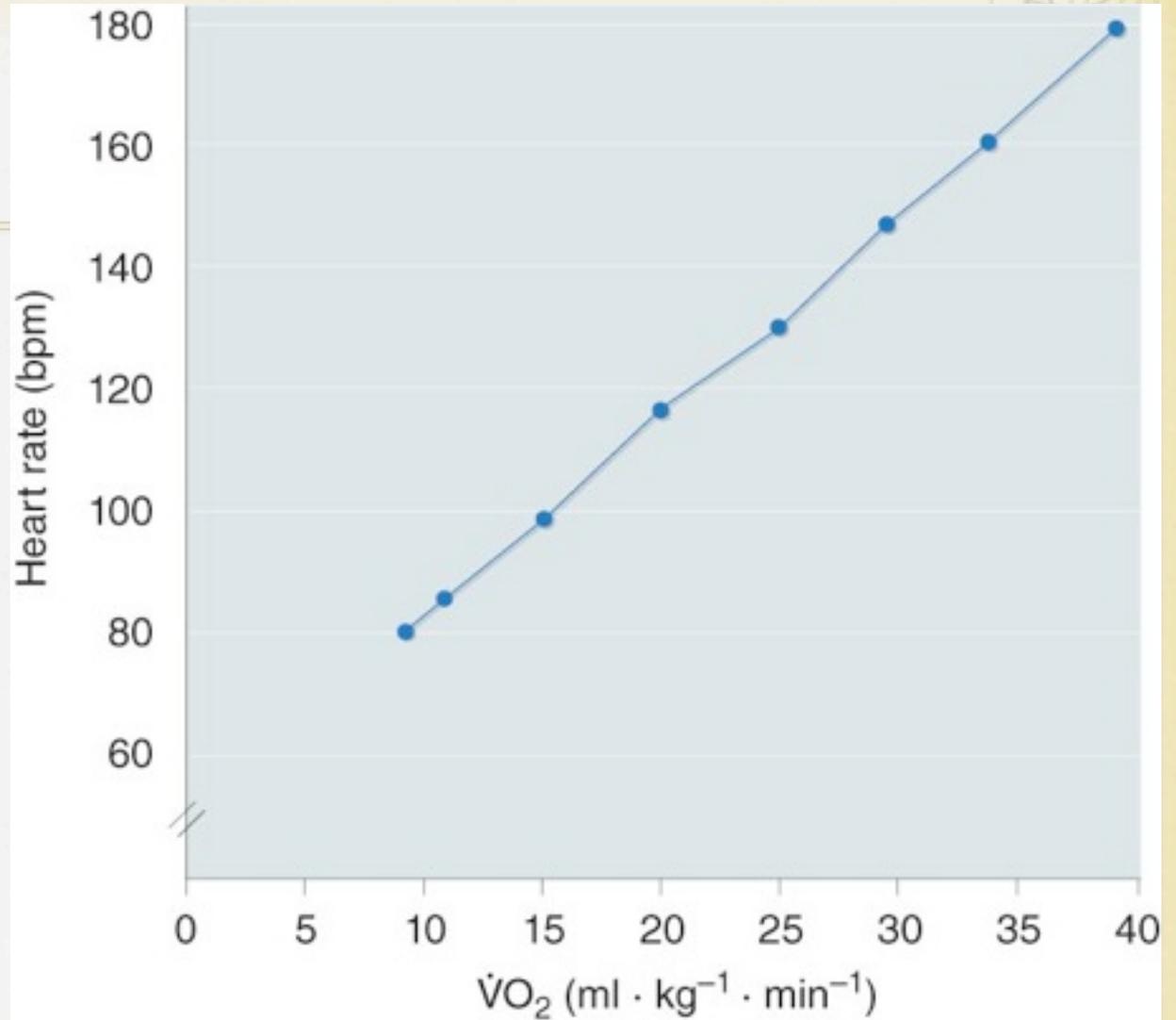


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# CARDIOVASCULAR SYSTEM

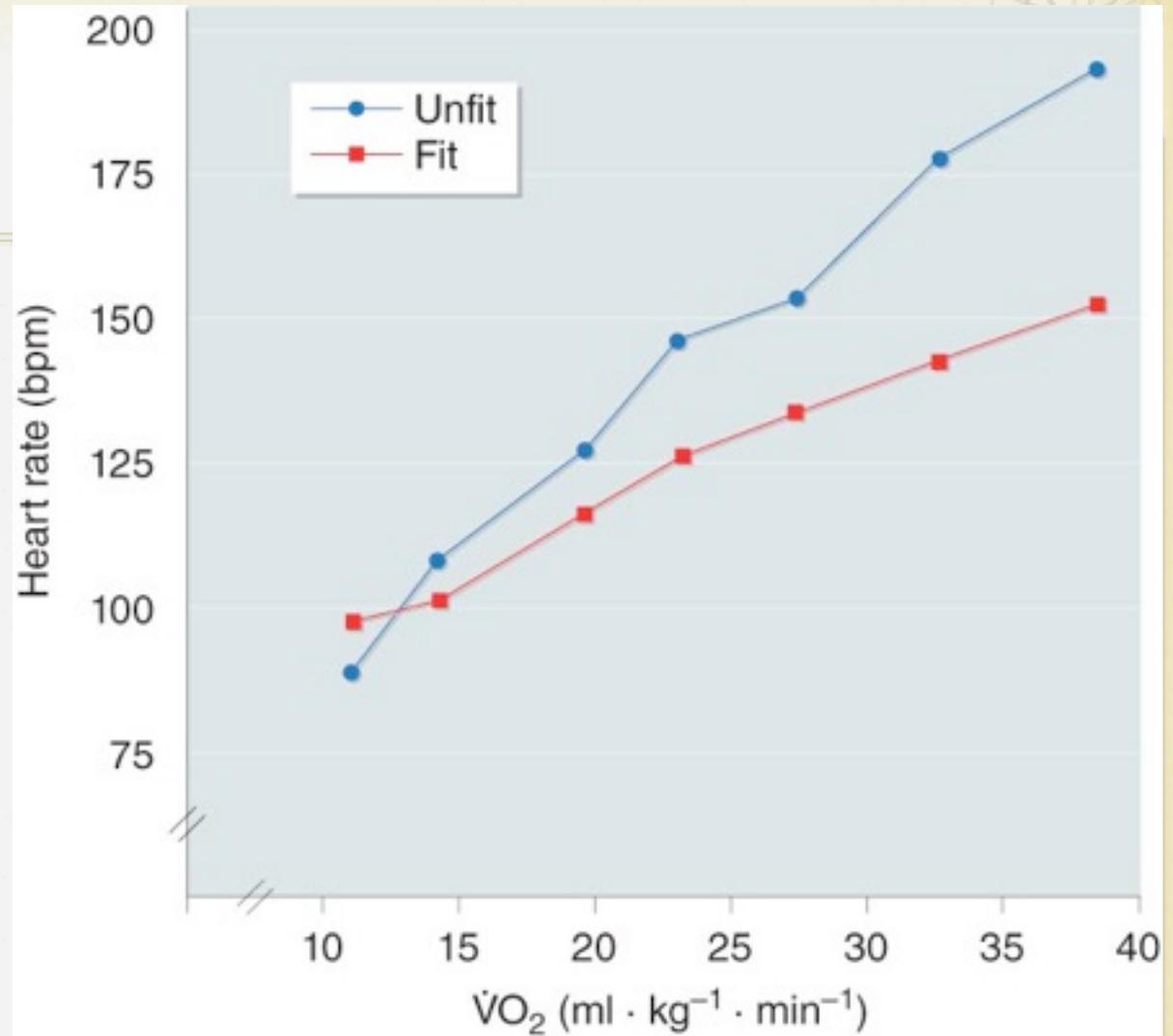
- Cardiac output: heart rate and stroke volume
  - most of the increase in  $VO_2$  max during training has been attributed to increase stroke volume
- Blood flow distribution
- Cardiorespiratory adaptations to training

# FIGURE 11.7



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# FIGURE 11.8

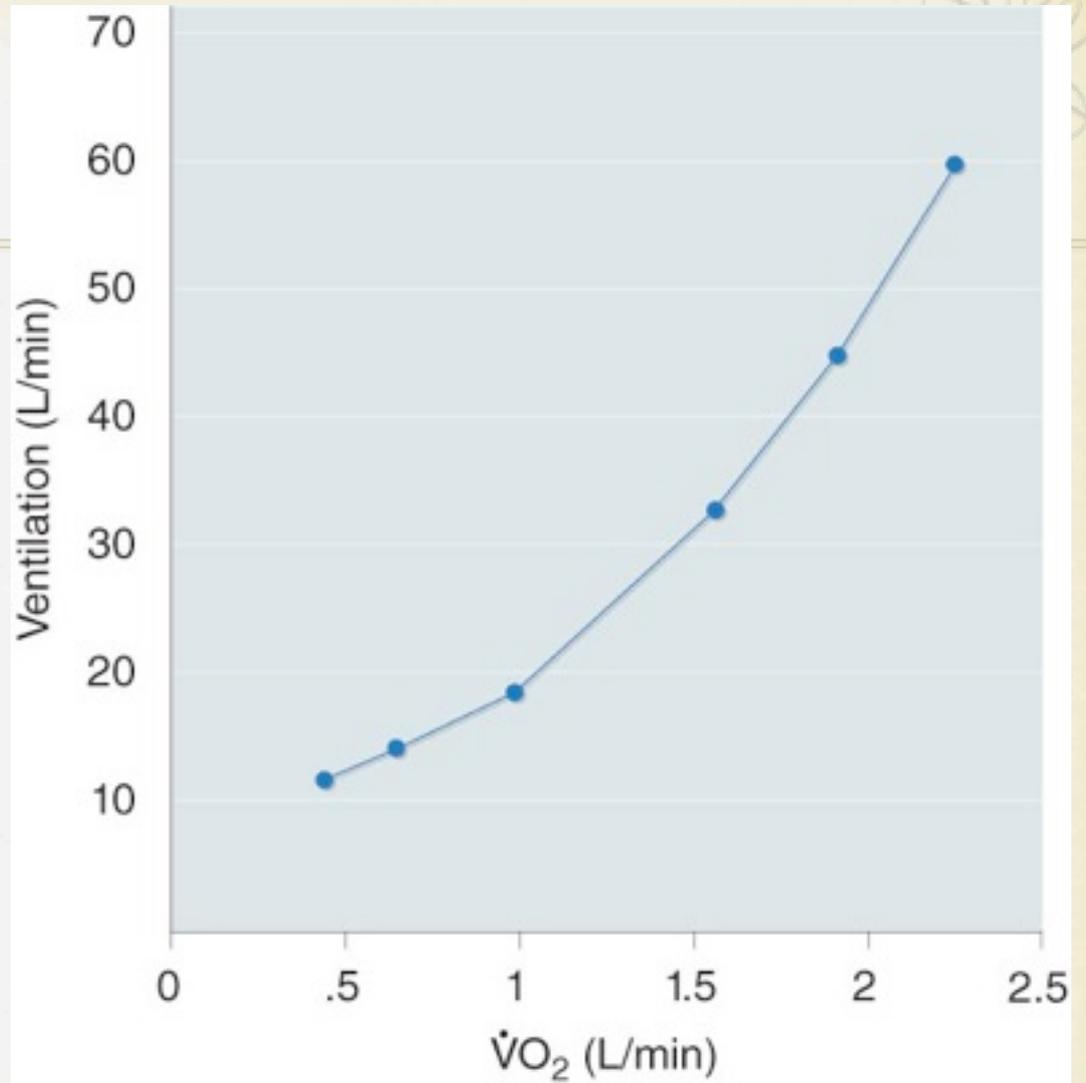


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# RESPIRATORY SYSTEM

Ventilation increases rapidly at the onset of physical activity and also as a function of exercise intensity.

# FIGURE 11.9

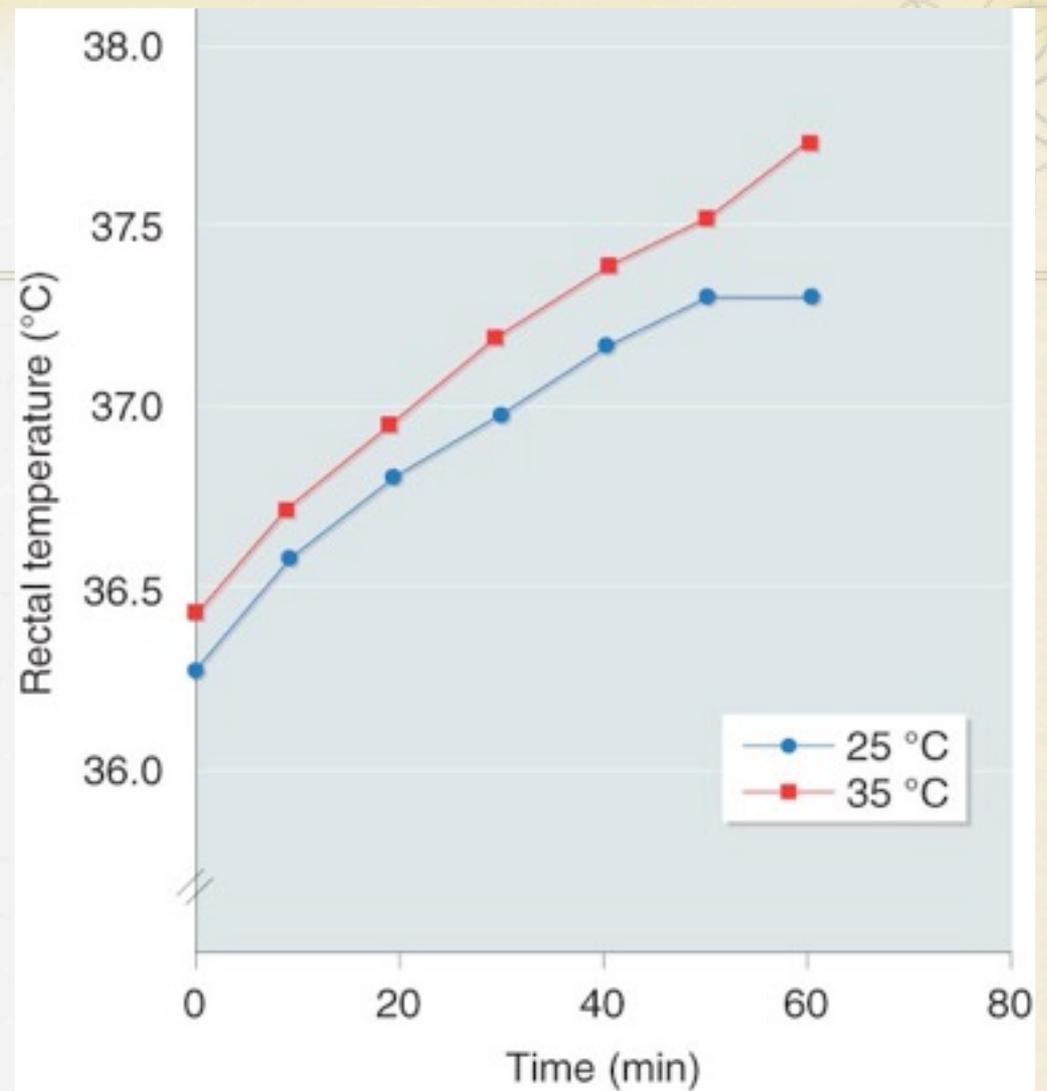


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# TEMPERATURE EFFECTS

- ✿ Effects of exercise
- ✿ Effects of acclimatization
- ✿ Muscle contractions produce heat, which helps maintain the body's internal temperature. During physical activity, increased heat production by skeletal muscles stimulates vasodilation of skin blood vessels and sweating.

# FIGURE 11.10



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# NUTRITIONAL EFFECTS

- ❖ Carbohydrate (primary source of muscle energy)
- ❖ Fluid intake (every 15-20 minutes)
- ❖ Iron intake
- ❖ The amount of glycogen stored is directly related to the carbohydrate content of the diet.
- ❖ Inadequate fluid intake will result in elevated body temperature, risk of developing a heat illness, and possible decrements in performance.

# PHYSICAL ACTIVITY, FITNESS, AND HEALTH

- ✿ The minimal recommended amount of physical activity for improvement in cardiorespiratory endurance is 20 to 60 minutes of activity at 70% to 94% of maximal heart rate, three to five days per week (ACSM 2006).
- ✿ Increased amounts and intensity can result in greater benefits, if injury and burnout are avoided.

*(continued)*

# PHYSICAL ACTIVITY, FITNESS, AND HEALTH

- Effects of age on fitness
- Physical activity, fitness, and coronary heart disease
- Physical activity and weight control

# PHYSIOLOGY OF PHYSICAL ACTIVITY

- Studies acute and chronic adaptations to physical activity for performance, fitness, and health improvements
- Studies cellular and total body physiology
- Studies the body's response to physical activity
  - Heat
  - Environment
  - Altitude
- Provides many career opportunities