

## Chapter 19

### Sex Differences and Athleticism: Endocrine, Skeletal, and Muscular Systems

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### 19.1 The Endocrine System

- The **endocrine system** is an internal system of regulation and communication involving
  - Hormones, hormone-secreting glands, and target cells (specific cells that respond to hormones)

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### Hormones

- **Hormones** are chemicals that travel in blood and act to elicit a response from target cells
- 2 general mechanisms by which hormones elicit a specific response:
  - Bind to receptors on target cell's surface and trigger a change inside cell
  - Diffuse into cells and bind to receptors inside the cell to trigger response

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### Hormones

- Protein hormones usually bind to a receptor on target cell surface, and that receptor stimulates a series of other proteins to become involved in relaying the message to the inside of the cell, eliciting a specific cellular response
- This triggering mechanism is called the **signal transduction pathway**

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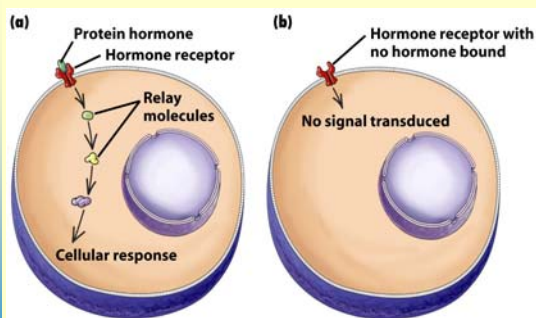


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### Hormones

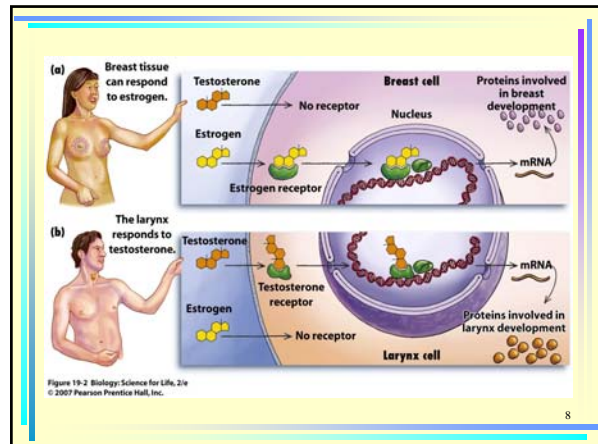
- Hormones involved in sex differences are called **sex hormones**
  - **Testosterone**: male hormone
  - **Estrogen**: female hormone
- Sex hormones are a type of steroid hormone made from cholesterol and which can easily cross cell membranes

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## Hormones

- Once in a cell, the sex hormone binds to a receptor and the complex binds to DNA to
  - Enhance gene expression
  - Inhibit gene expression

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## Endocrine Glands

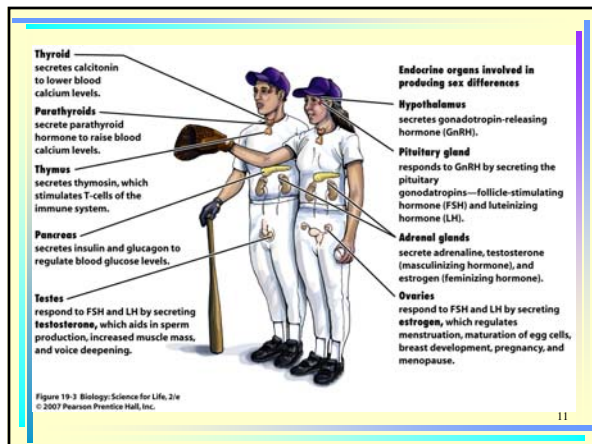
- Organs that secrete hormones are called **endocrine glands**
- Endocrine glands include
  - **Thyroid gland** – secretes hormones that stimulate metabolism
    - ✓ Along with the **parathyroid glands**, helps regulate blood-calcium levels
  - **Thymus** – produces some immune cells; part of the lymphatic system
  - **Pancreas** – helps regulate blood glucose levels

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## Endocrine Glands

- 5 other endocrine organs are involved in biological sex differences:
  - Hypothalamus
  - Pituitary gland
  - Adrenal glands
  - Ovaries
  - Testes

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## Hypothalamus and Pituitary Gland

- **Hypothalamus** – located in brain
  - Regulates body temperature
  - Affects behaviors including
    - ✓ Hunger
    - ✓ Thirst
    - ✓ Reproduction

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### Hypothalamus and Pituitary Gland

- In the reproductive system, the hypothalamus secretes a hormone that stimulates the activities of the **gonads** (testes or ovaries) called **gonadotropin-releasing hormone (GnRH)**
  - When released, GnRH travels to the **pituitary gland**

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### Hypothalamus and Pituitary Gland

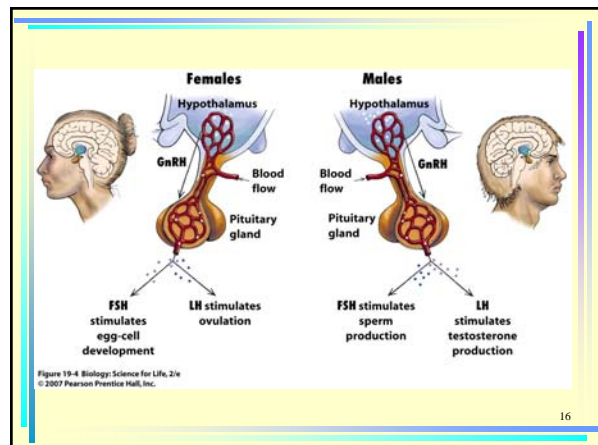
- Pituitary gland secretes many hormones
- Stimulated by GnRH to synthesis and release **pituitary gonadotropins**: involved in sex differences
  - **Follicle-stimulating hormone (FSH)**
  - **Luteinizing hormones (LH)**

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### Hypothalamus and Pituitary Gland

- In males
  - FSH stimulates sperm production
  - LH stimulates testosterone production
- In females
  - FSH stimulates egg-cell development
  - LH stimulates release of eggs during ovulation

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### Adrenal Glands

- Have 2 – one sits atop of each kidney
- Secrete **adrenaline** (epinephrine)
  - In response to stress / excitement
- Secrete **androgens**
  - Masculinizing hormones (testosterone)
- Secrete **estrogens**
  - Feminizing hormones

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### Testes

- Paired oval organs suspended in the scrotum
  - Kept outside the body cavity in the scrotum b/c sperm production is most efficient at temperatures that are lower than body temp.
- Secrete **testosterone**, which aids in:
  - Sperm production
  - Hair thickness / distribution
  - Increased muscle mass
  - Deep voice

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## Ovaries

- **Ovaries** are small, almond sized organs
  - Produce and secrete estrogen
  - Contain all the cells that can mature into egg cells that will be ovulated
  - Production of eggs begins while a female is in utero, pauses at birth, resumes at puberty, and continues until menopause
- **Estrogen** regulates:
  - Menstruation
  - The maturation of egg cells
  - Breast development
  - Pregnancy
  - **Menopause**, the cessation of menstruation

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## Puberty

- Puberty for boys:
  - The beginning of sperm production
  - Typically begins at age 9-14
  - Enlargement of penis and testes
  - Growth spurt
  - Changes in hair growth
  - Vocal cords lengthen

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## Puberty

- Puberty for girls:
  - The beginning of egg production
  - Typically begins at 8-13
  - Breast development
  - Growth spurt
  - Hair growth – pubic and underarm
  - Menstruation

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## 19.2 The Skeletal System

- The skeletal system
  - Provides support for the body
  - Protects internal organs
  - Aids in movement
  - Stores minerals

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## The Human Skeleton

- 206 bones organized into 2 basic units
  - **Axial skeleton**: spine and skull
  - **Appendicular skeleton**: hips, shoulders and limbs
- To allow a variety of movements, humans have different types of joints
  - **Ball-and-socket joints** – hips, shoulders
  - **Hinge joints** – knees, elbows
  - **Pivot joint** - neck

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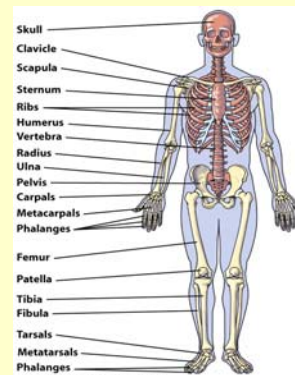
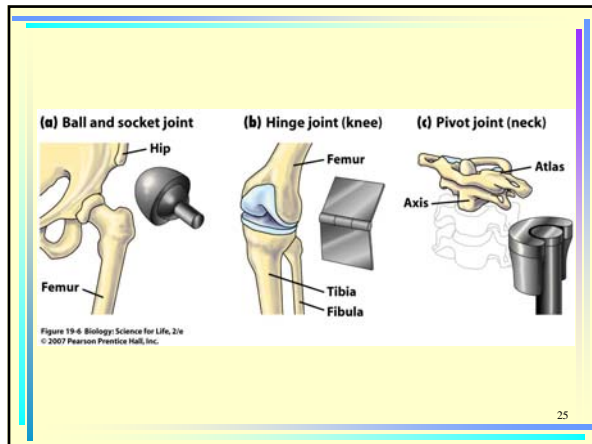


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### The Human Skeleton

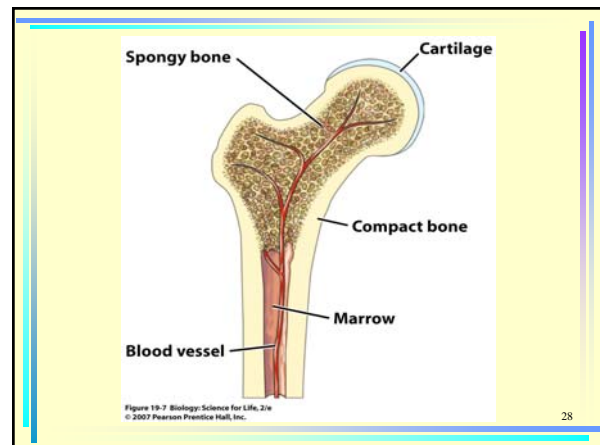
- To facilitate movement, joints are lined with cartilage and lubricated with fluids
- Bones are kept in place by ligaments and moved by muscles
- Bones are living tissues composed of cells that actively reshape the tissue
- Calcium is absorbed as bone is built and released when bone breaks down

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### Bone Structure and Remodeling

- **Compact bone**
  - Hard outer shell of bones
- **Spongy bone**
  - Porous, honeycomb-like inner bone
- **Bone marrow** is in the interior of bones, which helps to produce blood cells
- Blood vessels run throughout the bones

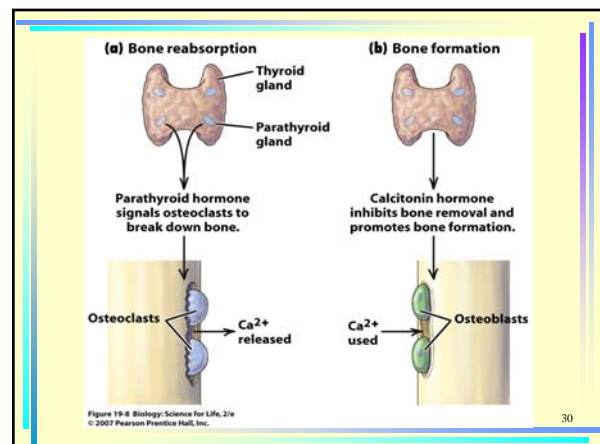
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### Osteoblasts, Osteoclasts, and Calcium

- Bone maintenance is controlled by bone cells (osteoclasts and osteoblasts) along with the endocrine system
- **Osteoblasts**
  - Help bone tissue regenerate itself by a process called bone deposition (building bone)
- **Osteoclasts**
  - Involved in breaking down or reabsorbing bone tissue

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### Osteoblasts, Osteoclasts, and Calcium

- The deposition/reabsorption process is controlled by a negative feedback loop
  - Calcium is put into blood in response to parathyroid hormone
  - Release of this hormone signals the kidneys to decrease the amount of calcium secreted in the urine and stimulates the breakdown of bone (done by osteoclasts), so that stored calcium is released into the blood – occurs when calcium levels are low

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### Osteoblasts, Osteoclasts, and Calcium

- If there is too much calcium in the blood, the thyroid gland secretes **calcitonin**
  - This causes osteoblasts to pick up calcium and make new bone

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### Osteoblasts, Osteoclasts, and Calcium

- Calcium levels in the blood are important for
  - Blood clotting
  - Muscle contraction
  - Nerve impulse production
  - Enzyme activity

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### Sex Differences in Bone Structure

- Sex differences in bone structure are due to puberty timing
- Puberty occurs later and lasts longer in boys
- Average adult man is 5.9 inches taller than the average adult woman

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### Sex Differences in Bone Structure

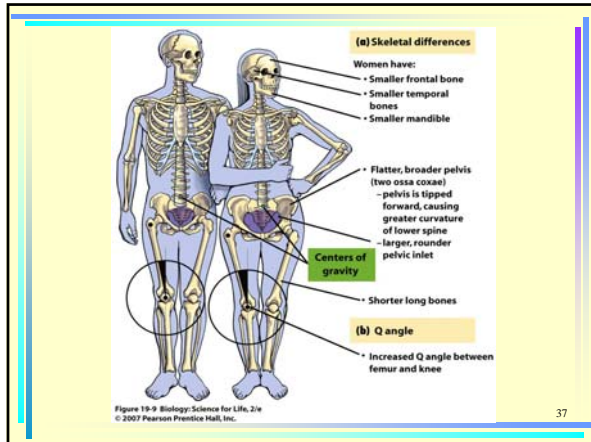
- These differences contribute to differences in abilities to successfully perform physical activities
- Because women generally have long torsos relative to their leg length, their center of gravity (the point on the body where the weight above equals the weight below) is lower than men
- Individuals with lower center of gravity are better able to maintain balance
  - Competitive gymnastics – women compete on the balance beam not men
  - Ice skating, ballet, and other forms of dance also require a lot of balance, and the lower center of gravity may enhance a woman's ability to stay on her feet

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### Sex Differences in Bone Structure

- Men are better in tasks that require leverage, because they have longer limbs that can transmit more force
  - Stronger kicks, arm swings, strides are differences in athleticism

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### Sex Differences in Bone Structure

- Other skeletal differences include:
  - The **mandible** (jawbone) is larger in men
  - The **temporal bones** (two bones near temple) have larger openings in males to allow for the connection of thicker muscles to support the large jaw
  - **Frontal bone** (forehead) is more rounded in females with less pronounced brow ridge
  - **Ossa coxae** (two bones in pelvis) have a round pelvic inlet in women from flatter and broader pelvic bones

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### Sex Differences in Bone Structure

- Another skeletal difference:
  - Q angle (the angle formed between kneecap and femur) increases as the broadness of the bony pelvis increase
    - ✓ Thought to be a sex-influenced risk factor for knee injury
      - This may be the result of differences in leg-muscle strength

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### 19.2 The Muscular System

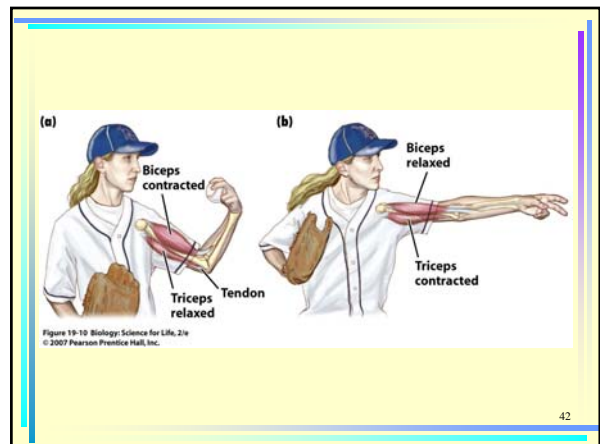
- The muscular system's major function is movement
- Three types of muscles in human
  - Skeletal
  - Cardiac
  - Smooth

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### Muscle Interaction with Bones

- Skeletal muscle attaches to bones at tendons
- Skeletal muscle is nourished by blood vessels – these cells need a lot of oxygen to make ATP for contractions
- Muscles and bones work together
- There are paired muscles
  - **Antagonistic pairs**
    - ✓ Biceps contracts and triceps is relaxed
    - ✓ Triceps contracts and biceps relaxes

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### Muscle Structure and Contraction

- The structure of muscle involves parallel filaments in bundles called muscle fibers
- Each **muscle fiber** is a single cell
- There are many filaments in each muscle cell
- These filaments are called **myofibrils** and are arranged in a striated or stripe pattern
- Each myofibril is a linear arrangement of **sarcomeres**, which are the unit of contraction of a muscle fiber

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### Skeletal muscle structure

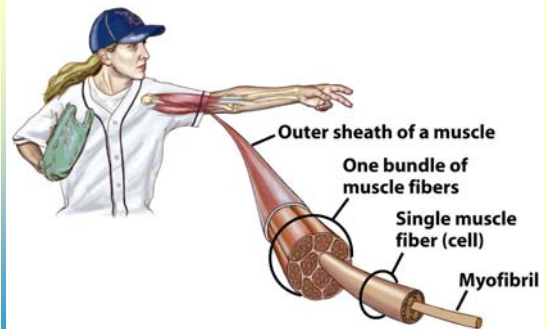


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### Muscle Structure and Contraction

- A sarcomere is composed of filaments of protein
  - Thin **actin** filaments
  - Thick **myosin** filaments
- The sarcomere is the region between two dark lines, called **Z discs**, in the myofibril
- To contract, the muscle fibers contract by shortening the sarcomeres

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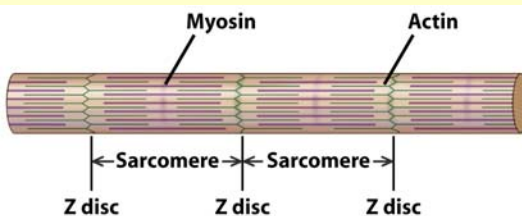


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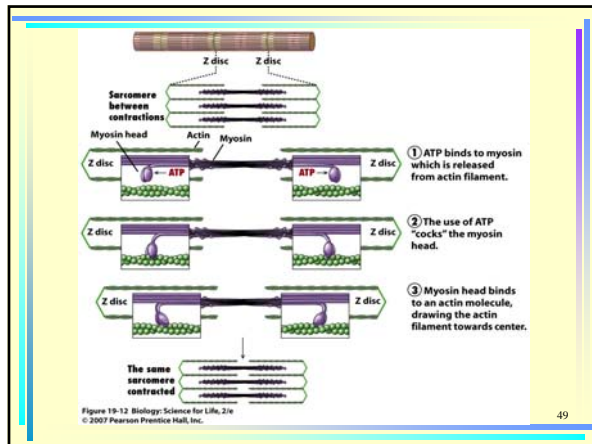
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### The Sliding-Filament Model of Muscle Contraction

- Sarcomere shortening involves coordinated sliding and pulling motions within the sarcomere
- Actin filaments are anchored at the Z discs at the ends of a sarcomere
- They overlap a parallel, stationary set of myosin molecules that are not attached to Z discs

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### The Sliding-Filament Model of Muscle Contraction

- During contraction
  - Actin filaments slide over the fixed myosin fibers
  - The ends of the sarcomere are pulled together
- The myosin head binds to the actin filament to pull it
- Then releases and binds again further down
- This pulls the actin filament in a stepwise manner (like hand-over-hand pulling of a rope)

### The Sliding-Filament Model of Muscle Contraction

- ATP binds to the myosin head
- The myosin head detaches from its binding site on the actin filament
- ATP provides the energy so the myosin head can pull
- Then the myosin head releases and binds to new site on the actin
- The sarcomere shortens in short powerful strokes
- The Z discs are pulled inward, shortening the sarcomere

### Sex Differences in Muscle

- Testosterone increases muscle fiber size
- Muscle fiber cells have receptors for testosterone, and the presence of testosterone stimulates the cells to increase in mass

### Sex Differences in Muscle

- Ovaries and adrenal glands do secrete a small amount of testosterone
  - But since males have more testosterone than females, muscles in males are bigger
- Therefore, there is a difference in strength in men and women

### Sex Differences in Muscle

- These differences mean...
  - In sports that require strength, males have an advantage
    - ✓ Such as football
  - In sports that require agility or hand-eye coordination, the differences are reduced
    - ✓ Such as baseball

### 19.4 Other Sex Differences That Influence Athleticism

- There are sex differences other than those involving the endocrine, skeletal, and muscular systems
- What they are is important, as is what they mean

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### Body-Fat Differences

- There are body-fat differences in amounts and locations
  - Women carry body fat in the torso, abdomen, hips, thighs, buttocks
  - Men carry most of their body fat in the abdomen
- Women have about 10% more body fat than men
  - This helps maintain fertility
  - If there isn't enough fat, hormones like estrogen and progesterone can be altered or not secreted
  - This causes menstruation to stop (**amenorrhea**)

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### Body-Fat Differences

- Lack of menstruation can be permanent, which results in sterility
- This can result in bone damage
  - Amenorrhea can be caused by starvation or excessive exercise

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### Body-Fat Differences

- Women metabolize fat differently than men, which can cause a slowing of glucose metabolism in women
  - So more sugars are available for prolonged exercise
  - May result in greater tolerance for endurance events for women

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### Body-Fat Differences

- In marathon events, women win as often as men
- Women's performances in marathons is getting better
- In 1972, the first year women were allowed to compete in marathons, the winning woman finished in 3:10:26 and the winning man finished in 2:15:39
- In 2004, the first man finished in 2:10:37 and the first woman finished in 2:24:27

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### Body-Fat Differences

- The increase in women's time (45 minutes faster) compared to the increase in men's time (5 minutes faster) may be due to training or coaching

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### Body-Fat Differences

- Extra body fat in women helps in long distance swimming events
  - Increases buoyancy
  - Easier to maintain streamlined swimming position
- In addition, extra body fat
  - Provides more insulation
  - Slows rate of body heat loss
  - Stores energy that can be converted to ATP during endurance events

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### Cardiovascular Differences

- Women have smaller hearts and less blood volume relative to body size
- Women have fewer blood cells per unit volume of blood than similarly sized men do
- This means that men are better able to supply oxygen and nutrients to their greater muscle mass

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### Cardiovascular Differences

- Women also have smaller lungs that work harder to transport oxygen to the cells and tissues that need it
- If a man and a woman of similar sizes are running next to each other, the woman's respiratory and cardiovascular systems would be working harder to supply tissue cells with oxygen

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### Group Differences and Individual Differences

- Average differences between men and women can be measured, but don't mean much in the real world
- Averages hide the range of values that exist within males and females
- The ranges overlap

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### Group Differences and Individual Differences

- For body fat:
  - Average woman – 22%
  - Average man – 14%
- But the range of body fat
  - For women – 12% - 32%
  - For men – 3% - 29%

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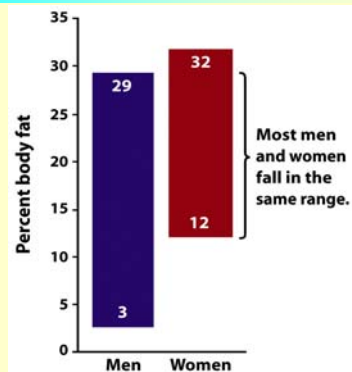


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### Group Differences and Individual Differences

- Most males and females fall within the range of 12 – 29% body fat
- You can't tell gender from body fat percentage
- The differences within a group (individual based) are often greater than the differences between two groups (group based)
- This limits assumptions we can make about athletic performance

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### Group Differences and Individual Differences

- 10 randomly chosen men and 10 randomly chosen women
  - Time them running 100 meters
- Time ranges for males and females would overlap
- If the 10 women were from the track team, their times would be at the fastest end of the range
  - Maybe faster than any random 10 men

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### Group Differences and Individual Differences

- So it is impossible to predict a person's time based on gender
- There may be some differences in athleticism that are attributable to gender, but there are other factors

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### Group Differences and Individual Differences

- Culture may also play a role
  - Ila Borders wasn't allowed to register for little league when she was 10
  - In college, she was the first woman to receive a baseball scholarship and was the only woman on the team
  - She was taunted both by her own teammates and from the other team
- Now, more than 100,000 women compete in intercollegiate sports

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### Group Differences and Individual Differences

- Physical activity is important to overall health, regardless of gender
- Children who participate in sports are less likely to drop out of high school, smoke, or drink
- Participation in sports teaches
  - Teamwork
  - Discipline
  - Pride in accomplishment
  - Drive
  - Dedication

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### Group Differences and Individual Differences

- Children who exercise are more likely to exercise as adults
- Adults who are physically fit have a decreased risk of
  - Heart disease, obesity, diabetes, and cancer
  - Also, lowered cholesterol and possibly decrease in anxiety and depression
- Sex differences that lead to differences in strength, speed, balance, and endurance are meaningless for recreational athletes
- It is more important for them to find an enjoyable activity

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