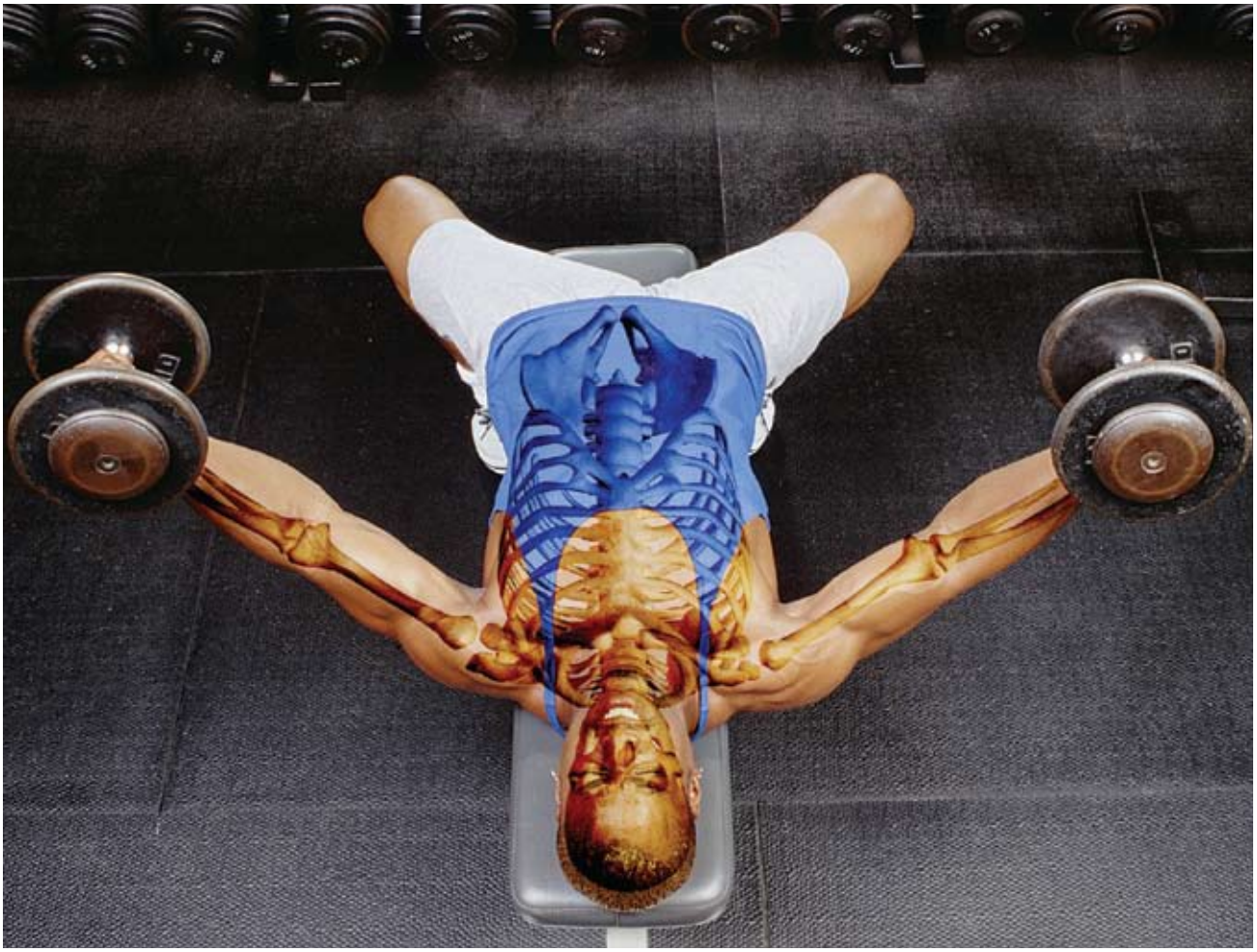
CHAPTER 2



Human Anatomy: The Pieces of the Body Puzzle

After completing this chapter you should be able to:

- demonstrate an understanding of the basis for anatomical description and analysis;
- use correct anatomical terminology when describing the human body and performance;
- describe the various parts of the skeletal and muscular systems and the ways in which they relate to human performance;
- demonstrate an understanding of the organization and complexity of human anatomy.

The human body has fascinated the human mind for centuries. What enables us to run, jump, and throw? How are we able to move our fingers with such remarkable dexterity? What are the structures that allow us to perform the myriad of tasks we do? The study of the structures that make up the human body, and how those structures relate to each other, is called **human anatomy**. Questions concerning human anatomy continue to capture the curiosity of human beings worldwide because it is a subject that binds all humans together. An understanding of how our bodies are structured to perform is important if we are to gain our full potential, especially in the world of sport and physical activity.

It is important to realize that structure often determines function; the structures of the human body are well designed for efficient movement. You have probably marvelled at the strength of the human skeleton that is able to withstand great impact and stress, not to mention its light weight that allows movements to be swift and active. The human body is undoubtedly a strong, flexible, well-oiled machine, able to move and perform with astonishing efficiency (Figure 2.1). But what structures allow some power lifters to lift weights two or three times their own body weight? How does Tyson Gay run a distance of 100 meters under 10 seconds?

In fact, how are we able to stand upright and move against gravity and other forces? The science of anatomy attempts to shed light on these and other questions, as well as to provide answers based on the complex and intricate structure of the human body.

Many systems make up the human body. Some of them are the respiratory, urogenital, cardiovascular, nervous, endocrine, digestive, and musculoskeletal. The cardiovascular and nervous systems are essential to the musculoskeletal system and are presented in Chapters 7 and 11, respectively. In this chapter we will deal with the musculoskeletal system.

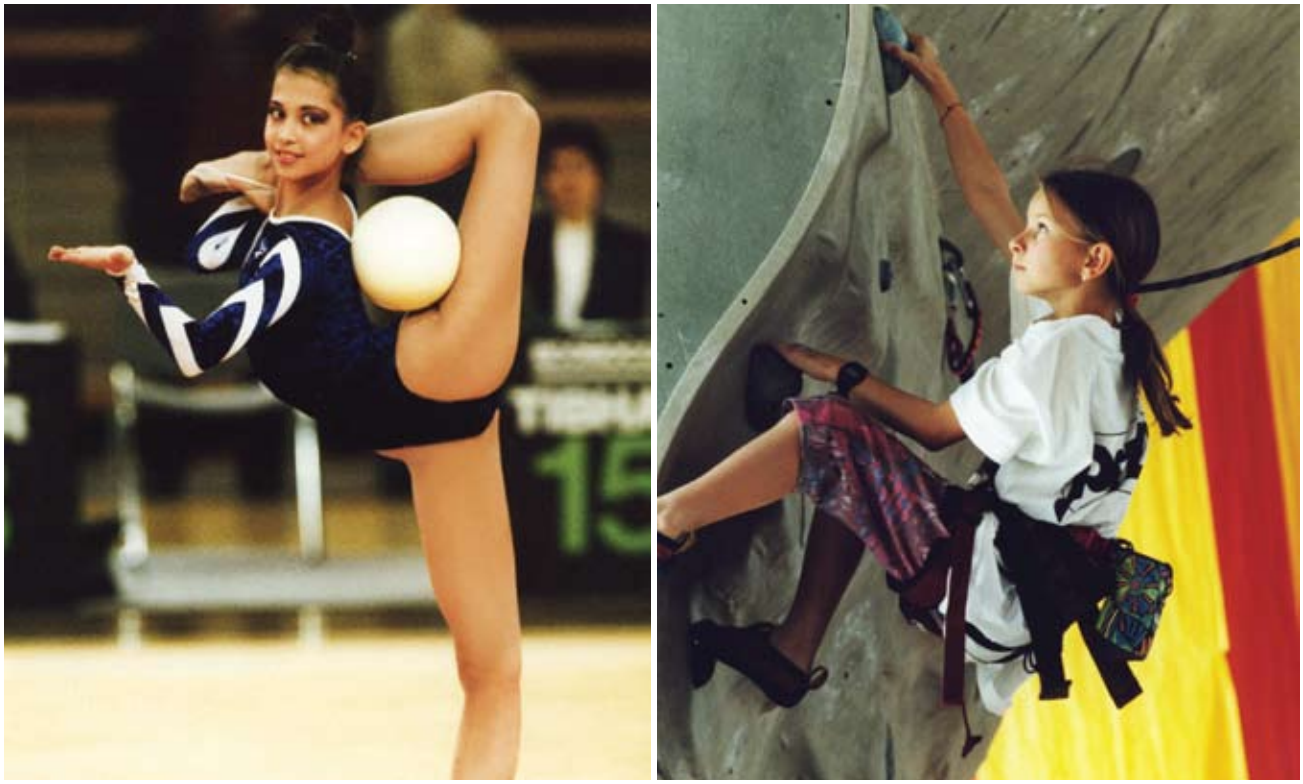
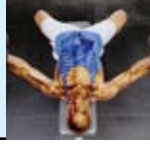


Figure 2.1 The human body is capable of moving gracefully and performing very challenging tasks.



Terms and Concepts Worth Knowing

In order to describe anatomy with clarity, there is a certain language or terminology to be learned. The language of anatomy may be difficult to grasp at first because it is largely unfamiliar to you; but once you gain a general understanding of the word roots, suffixes, and prefixes commonly used in anatomy, the terminology will become increasingly meaningful. For example, if you know that *myo* refers to muscle and that *cardio* pertains to the heart, you can reach the conclusion that *myocardium* refers to the muscle of the heart. The knowledge of some basic terms and concepts is invaluable for improving your understanding of anatomy.

Front to Back

The terms "ventral" and "dorsal" were used originally to describe positions in four-legged animals. In bipedal humans (two-legged animals such as ourselves) the terms "anterior" and "posterior" are used. However, the terminology "ventral" and "dorsal" may appear in some texts.

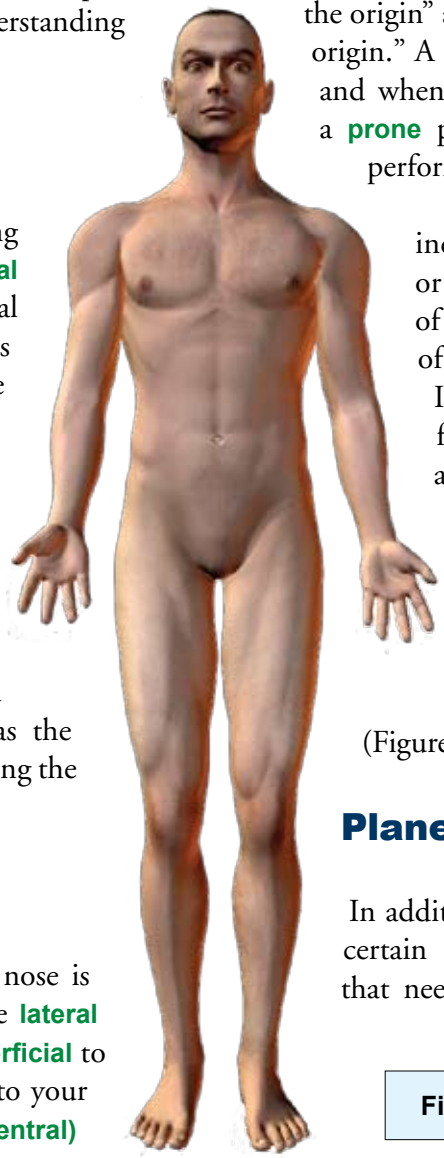
Anatomical Position

Of particular importance to studying anatomy is the basic **anatomical position**. It is used in all anatomical description, specifying the locations of specific parts of the body relative to other body parts; it can best be learned by you, the student, in the following position: standing erect, facing forward, arms hanging at the sides with palms facing forward, legs straight, and heels and feet together and parallel to each other. The anatomical position is universally accepted as the starting reference point for describing the human body (Figure 2.2).

Directional Terms

In the anatomical position, your nose is **medial** to your eyes, your ears are **lateral** to your cheeks, your skin lies **superficial** to your muscles, your heart is **deep** to your ribcage, your lips are **anterior (ventral)** to your teeth, your back is **posterior (dorsal)** to your abdomen, and your lips are **superior** to your chin. Also, the hands are **distal** to the arms, and the arms are **proximal** to the hands. The terms proximal and distal are also used to describe nerves and blood vessels, proximal meaning "toward the origin" and distal meaning "away from the origin." A person lying on his back is **supine** and when lying face down is said to be in a **prone** position (e.g., when preparing to perform a push-up).

Each of the terms described here indicates the location of a body part or position in relation to another part of the body, giving a clear indication of where body parts may be found. If you want to locate the abdomen, for example, you would say, "The abdomen is **inferior** to the thorax," rather than saying, "The abdomen is below the thorax." It is important to note, however, that directional terms are based on the assumption that the body is in the anatomical position (Figure 2.2).



Planes of the body

In addition to directional terms, there are certain planes (imaginary flat surfaces) that need to be defined and understood;

Figure 2.2 The anatomical position.

Directional Terms

Superior – *Nearer to the head*
The head is superior to the thorax.

Inferior – *Nearer to the feet*
The stomach is inferior to the heart.

Anterior (Ventral) – *Nearer to the front*
The quadriceps are anterior to the hamstrings.

Posterior (Dorsal) – *Nearer to the back*
The hamstrings are posterior to the quadriceps.

Superficial – *Nearer to the surface of the body*
The skin is more superficial than muscle.

Deep – *Farther from the surface of the body*
The heart lies deep to the ribs.

Medial – *Nearer to the median plane*
The nose is medial to the eyes.

Lateral – *Farther from the median plane*
The eyes are lateral to the nose.

Distal – *Farther from the trunk*
The hands are distal to the arms.

Proximal – *Nearer to the trunk*
The arms are proximal to the hands.

they divide the body for further identification of particular areas. These terms always refer to the body in the anatomical position. For an individual standing in the anatomical position, the point at which the median, frontal, and transverse planes intersect represents the body's center of gravity (center of mass).

The **median plane** or **midsagittal plane** is a vertical plane that bisects the body into right and left halves; the **sagittal plane** is any plane parallel to the median plane; the **frontal plane** or **coronal plane** is any vertical plane at right angles to the median plane; and the **transverse plane** or **horizontal plane** is any plane at right angles to both the median and frontal planes (Figure 2.3).

These planes can also be used to describe different movements or actions, being described as sagittal, frontal, or transverse plane movements when they occur in a plane that is parallel to one of these planes. For example, a forward roll would be considered a **sagittal plane movement** because the forward and backward motion is parallel to the sagittal plane. Other sagittal plane movements include cycling and running. Similarly, movements that are lateral, or side-to-side in nature, can be described as **frontal plane movements**; some good examples are cartwheels, jumping jacks, and side-stepping. Can you think of any activities that would be considered **transverse plane movements**? How about a twist performed by a diver, or a pirouette in ballet?

Although many movements do not occur in any one plane, large movements and movements that occur at joints can often be described as being sagittal, frontal, or transverse plane movements; therefore, these reference planes still remain useful for describing human movement.

Joint Movements

Most movements are often found in pairs: for every movement, there is generally a movement that is opposite to it. There are exceptions, but the following descriptions apply to most joints and are illustrated in Figure 2.4.

Flexion–Extension

This usually occurs in a sagittal plane. In general, **flexion** reduces the angle between two bones at a joint and **extension** increases it. Consider the elbow joint when a biceps curl is performed. Lifting the weight requires flexion (reducing the angle at the joint), while lowering the weight involves extension (increasing the angle at the joint). These terms are modified in certain actions, for example, at the ankle joint, where the terms *dorsiflexion* (motion bringing the top of the foot toward the lower leg or shin) and *plantar flexion* ("planting" the foot) are used.

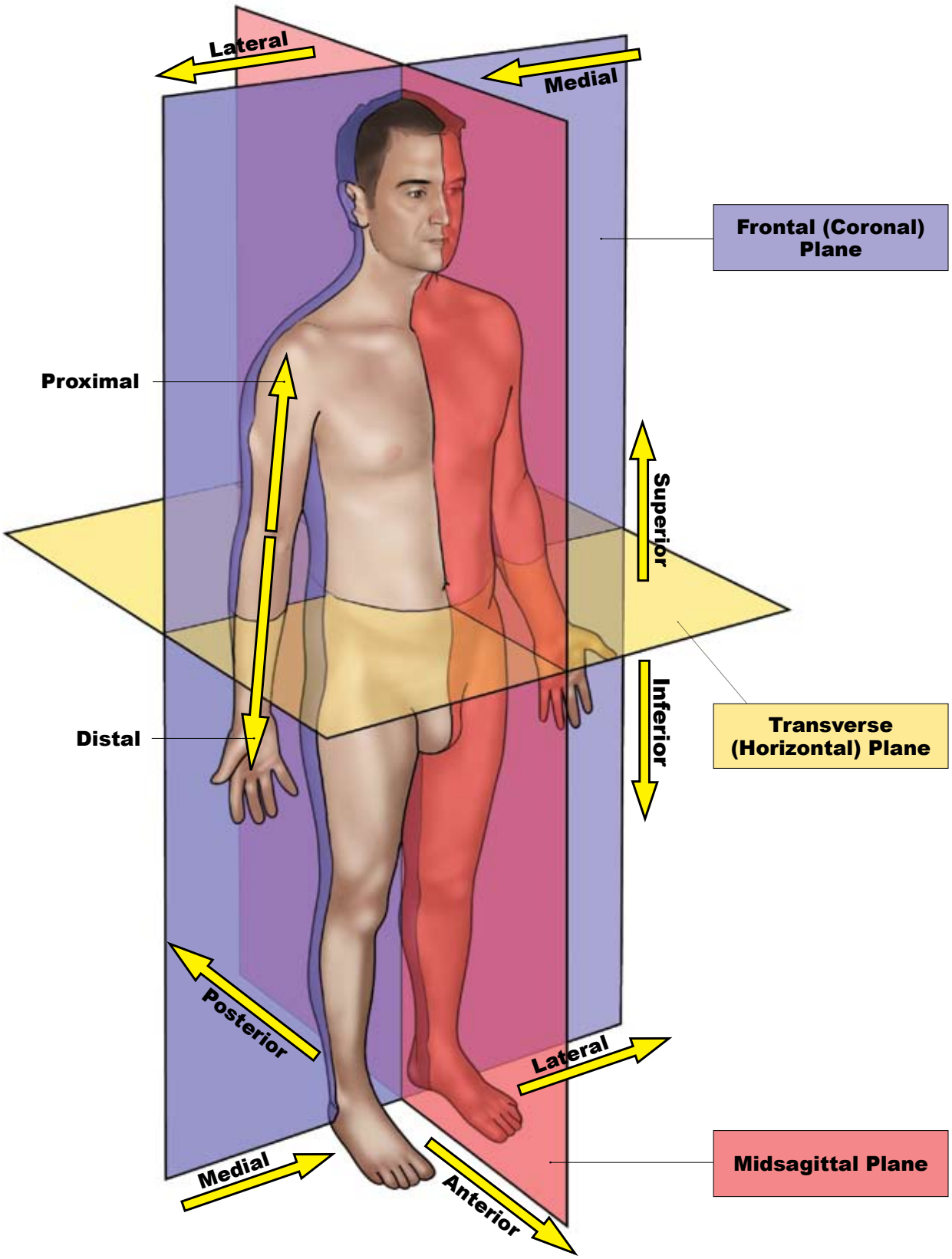
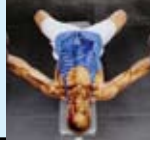


Figure 2.3 Anatomical position, directional terms, and planes of the body.

Figure 2.4 Major body movements around joints.



Abduction–Adduction

In general, **abduction** is movement away from the midline of the body and **adduction** is movement toward the midline of the body in the frontal plane. The motions of the arms and legs during a jumping jack are examples of these two types of movements.

Circumduction

When flexion–extension movements are combined with abduction–adduction movements, a cone of movement occurs but does not include any rotation. Tracing an imaginary circle in the air with your index finger while the rest of the hand remains stationary produces **circumduction**. The tip of your finger represents the base of the cone, while your knuckle forms the apex of this conical motion. This movement can occur at other moving body segments such as the hip and shoulder.

Rotation

A bone may also rotate along its longitudinal axis. To illustrate this action, flex your right elbow, place your left hand on your right shoulder, and now rotate your right arm so that your hand is carried toward your abdomen. This movement toward the median plane is called **medial** or **internal rotation**. When you rotate your arm back to the original position or out laterally, this is called **lateral** or **external rotation**.

Pronation–Supination

This movement is used to describe movements relative to the forearm and hand. When the palm is moved to face anteriorly, this is **supination** (you can hold a bowl of soup); when the palm is moved to face posteriorly, it is **pronation**. These actions are required when turning a door knob, opening a jar, or performing a topspin shot in tennis.

Inversion–Eversion

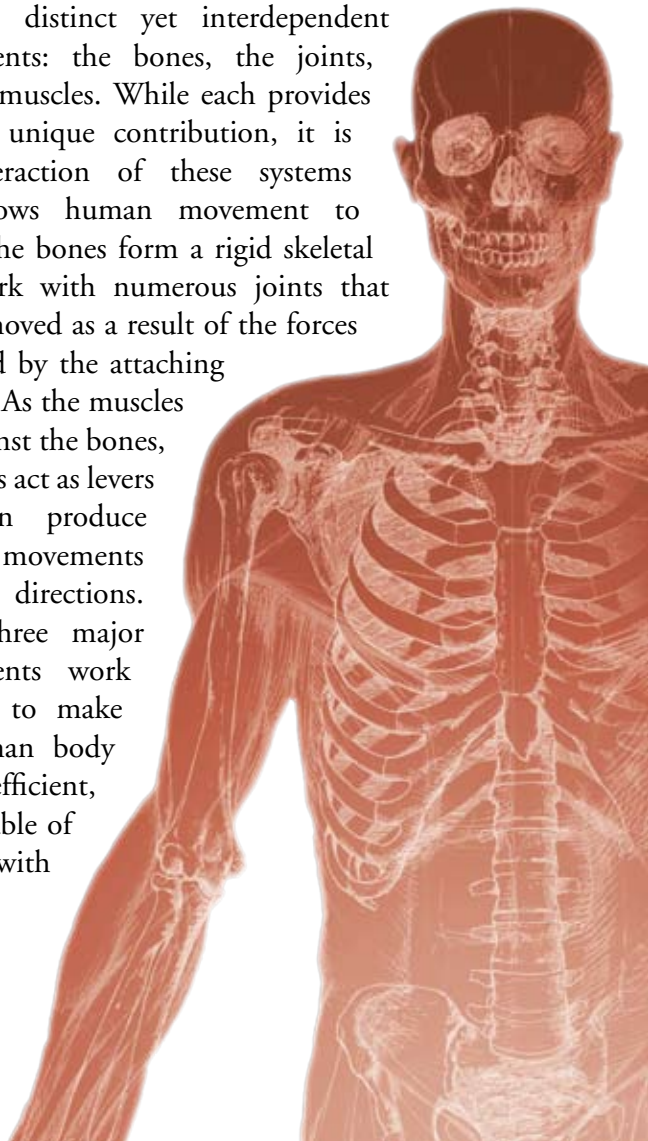
This movement is relative to the sole of the foot. When the sole is turned inward (as when you "go over" on your ankle) it is inverted: this movement is called **inversion**. Injuries are common at the ankle joint, occurring when the joint is severely inverted beyond its normal range of motion. When the sole is turned outward or away from the median plane of the body, it is everted: this movement is called **eversion**.

Dorsiflexion–Plantar Flexion

The movement of the ankle so that the dorsal surface of the foot moves superiorly is called **dorsiflexion**. It is the opposite of **plantar flexion**, which draws the foot inferiorly in the anatomical position. These actions occur when standing on the toes or using the pedals of a car while driving.

The Musculoskeletal System

The musculoskeletal system is composed of three distinct yet interdependent components: the bones, the joints, and the muscles. While each provides its own unique contribution, it is the interaction of these systems that allows human movement to occur. The bones form a rigid skeletal framework with numerous joints that can be moved as a result of the forces produced by the attaching muscles. As the muscles pull against the bones, the bones act as levers that can produce diverse movements in all directions. These three major components work together to make the human body strong, efficient, and capable of moving with grace.



Bones of the Human Body

The bones of the human body provide the supporting framework and protection for the vital organs of the body – living tissue complete with blood supply and nerves. Remember how painful it is to hit your shin on something firm and sharp?

Bone Shape

Bone can be classified by shape as **short** (e.g., bones of the wrist and ankle), which serve as good shock absorbers; **long** (like the femur of the thigh and the humerus of the upper arm), with proximal and distal enlargements; **flat** (like the bones of the skull and scapula), which largely protect underlying organs and provide areas for muscle attachment; **irregular** (like the bones of your face and vertebrae), which fulfill special functions; and **sesamoid** (shaped like a pea and found in tendons). The structures and shapes of the bones of the human body allow them to perform specific functions more effectively (Table 2.1).

Bone Classification

The amount of mineral content in bone varies with one's age but also with the specific bone in the body. Bones that are more **porous** have a smaller proportion of calcium phosphate and carbonate, and greater nonmineralized tissue. According to the degree of porosity, bone can be classified into two general categories. Bone that has low porosity is called **cortical bone** (Figure 2.5). It is less flexible and can resist greater stress. In contrast, **spongy** or **cancellous bone** has a relatively high porosity with more nonmineralized tissue. Spongy bone has

Table 2.1 Bone classifications.

Shape	Examples	Skeleton
Long	Femur, tibia, fibula, humerus, radius, ulna, metatarsals, metacarpals, phalanges	Appendicular
Short	Carpals, tarsals	Appendicular
Flat	Scapula Clavicle Ribs, sternum Frontal, parietal, occipital, mandible	Appendicular Appendicular Axial Axial
Sesamoid	Patella	Appendicular
Irregular	Facial bones of skull, vertebrae Pelvis	Axial Appendicular