When damaged by mechanical or other injuries, tissues have varying capacity to repair themselves. Damaged tissue will regenerate or be replaced by tissue we know as **scars**. Tissues usually repair themselves by allowing the *phagocytic* cells to remove dead or injured cells, then filling in the gaps that are left. This growth of new tissue is called *regeneration*. Epithelial and connective tissues have the greatest capacity to regenerate. When a break in an epithelial membrane occurs, as in a cut, cells quickly divide to form daughter cells that fill the wound. In connective tissues, cells that form collagen fibers become active after an injury and fill in a gap with an unusually dense mass of fibrous connective tissue. If this dense mass of fibrous tissue is small, it may be replaced by normal tissue later. If the mass is deep or large, or if cell damage is extensive, it may remain a dense fibrous mass and form a scar.

Muscle tissue, on the other hand, has a very limited capacity to regenerate and thus heal itself. Damaged muscle is often replaced with fibrous connective tissue instead of muscle tissue. When this happens, the organ involved loses some or all of its ability to function. Like muscle tissue, nerve tissue also has a limited capacity to regenerate. Neurons outside the brain and spinal cord can sometimes regenerate, but very slowly and only if certain *neuroglia* are present to “pave the way.” In the normal adult brain and spinal cord, neurons do not grow back when injured. Thus brain and spinal cord injuries nearly always result in permanent damage.

**Histology - A Study of Tissues**

Cells are highly organized living units, but they typically do not function alone. Instead, cells work together in groups called tissues. A **tissue** is a group of similar cells, usually with a common embryonic origin, that function together to carry out specialized activities. **Histology** is the science that deals with the study of tissues. A **pathologist** is a physician who specializes in laboratory studies of cells and tissues to help other physicians make accurate diagnoses. One of the principal functions of a pathologist is to examine tissues for any changes that might indicate disease.
Classification of Body Tissue

Body tissues are classified into four basic types based on their structure and function:
1. **Epithelial tissue**
2. **Connective tissue**
3. **Muscular tissue**
4. **Nervous tissue**

Tissues differ from each other in the sizes and shape of their cells, in the amount and type of material between the cells, and in the special functions they perform to help maintain the body’s survival.

Most epithelial cells and some muscle and nerve cells are tightly joined into functional units by points of contact between their plasma membranes called cell junctions. Some cell junctions fuse cells together so tightly that they prevent substances from passing between the cells. This fusion is very important for tissues that line the stomach, intestines, and urinary bladder because it prevents the contents of these organs from leaking out. Other cell junctions hold cells together so that they don’t separate while performing their functions. Still other cell junctions form channels that allow ions and molecules to pass between cells. This permits cells in a tissue to communicate with each other and it also enables nerve or muscle impulses to spread rapidly among cells.

Epithelium - A Cover Story

**Epithelial tissue**, or more simply epithelium, forms the outer covering of the skin and the outer covering of some internal organs. It also lines body cavities, blood vessels, ducts, and the interiors of the respiratory, digestive, urinary, and reproductive systems. Epithelium, along with nervous tissue, forms portions of the sense organs for hearing, vision, and touch.

Epithelium is classified by the shape of its cells and according to the arrangement of these cells into layers. The three cell shapes are:
1. **Squamous** - thin and flat.
2. **Cuboidal** - cube shaped; cells are as tall as they are wide.
3. **Columnar** - cells are much taller than they are wide.

Arrangement of cells in layers:
1. **Simple** - single layer of the same cell shape.
2. **Stratified** - many layers of the same cell shape.
3. **Transitional** - several layers of cells of differing shapes.

General features of epithelium:
- Cells have a free surface which is exposed to a body cavity, lining of an internal organ, or the exterior of the body.
- **Avascular** - lacks blood vessels.
- **Basement membrane** - separates the epithelium from the underlying connective tissue.

Who’s Nervous?

Despite the awesome complexity of the nervous system, it consists of only two principal types of cells: neurons and neuroglia. **Neurons** or **nerve cells** are sensitive to various stimuli. They convert stimuli into nerve impulses (action potentials) and conduct these impulses to other neurons, to muscle fibers, or to glands. **Neuroglia** do not generate or conduct nerve impulses, but they do have many other important supportive functions.

All neurons are characterized by a **cell body** and two types of processes: one **axon**, which transmits a nerve impulse away from the cell body, and one or more **dendrites**, which carry impulses toward the cell body.
Are You Connected?

Connective tissue is the most abundant and widely distributed tissue in the body. It also exists in more varied forms than any of the other tissue types. It is found in skin, membranes, muscles, bones, nerves, and all internal organs. Connective tissue exists as delicate, paper-thin webs that hold internal organs together and give them shape. It also exists as strong and tough cords, rigid bones, and even in the form of a fluid - blood.

The functions of connective tissue are as varied as its structure and appearance. It connects tissues to each other and forms a supporting framework for the body as a whole and for its individual organs. As blood, it transports substances throughout the body. Several other types of connective tissue function to defend us against microbes and other invaders.

Connective tissue consists of two basic elements: cells and intercellular matrix. A connective tissue’s intercellular matrix is the material between its widely spaced cells. The matrix consists of protein fibers and ground substances, the material between the cells and the fibers. The matrix is usually secreted by the connective tissue cells and determines the tissue’s qualities. For instance, in cartilage, the matrix has the consistency of firm rubber. The matrix of bone, by contrast, is hard and rigid. Tendons and ligaments have a matrix that is strong and flexible, while the matrix of blood is liquid - known as plasma.

The types of connective tissue cells vary according to the type of tissue and include the following:

- **Fibroblasts** - most numerous; secretes the fibers and ground substances of the matrix.
- **Macrophages** - provides immunity; capable of engulfing bacteria and cellular debris by phagocytosis.
- **Plasma cells** - produced from B lymphocytes; secretes antibodies, thereby providing immunity.
- **Mast cells** - produces histamine which promotes the inflammatory response.
- **Adipocytes** - fat cells or adipose cells which stores triglycerides (fats).

I’m Bound For Muscle

Muscle tissue consists of elongated cells called muscle fibers that are highly specialized to generate force. As a result of this characteristic, muscular tissue produces motion, maintains posture, and generates heat. It also offers protection. Based on its location and certain structural and functional characteristics, muscular tissue is classified into three types: skeletal, cardiac, and smooth.

**Skeletal muscle** is named for its location. It is usually attached to the bones of the skeleton. It is also known as voluntary (or striated) muscle because we can consciously control our body movements. When viewed under the microscope, skeletal muscle is characterized by many cross striations with many nuclei per cell.

**Cardiac muscle** forms the bulk of the wall of the heart. Also, its regular but involuntary contractions produce the heartbeat. Under the microscope, cardiac muscle fibers have cross striations (like skeletal muscle) and thicker dark bands called intercalated disks.

**Smooth muscle** tissue is located in the walls of hollow internal structures such as blood vessels, airways to the lungs, the stomach, intestines, gallbladder, and urinary bladder. Smooth (visceral) muscle is said to be involuntary because it is not under conscious control. Under the microscope, smooth muscle cells are seen as long, tapered fibers that appear smooth (without striations) and have one nucleus per cell.
Tissues and Fitness

Achieving and maintaining an ideal body weight is a health-conscious goal. However, a better indicator of health fitness is body composition. Exercise physiologists assess body composition to identify the percentage of the body made of lean tissue and the percentage made of fat. Body-fat percentage is often determined by using calipers to measure the thickness of skin folds at certain places on the body. A person with low body weight may still have a high ratio of fat to muscle, an unhealthy condition. In this case the individual is “underweight” but “overfat.” In other words, fitness depends more on the percentage and ratio of specific tissue types than the overall amount of tissue present.

Therefore one goal of a good fitness program is a desirable body-fat percentage. For men, the ideal is 15% to 18%, and for women, the ideal is 20% to 22%. Because fat contains stored energy (measured in calories), a low-fat percentage means a low-energy reserve. High body-fat percentages are associated with several life-threatening conditions, including cardiovascular disease. A balanced diet and an exercise program ensures that the ratio of fat to muscle tissue stays at a level appropriate for maintaining homeostasis.

Membranes As Organs

Membranes are flat sheets of pliable tissue that cover or line a part of the body. The combination of an epithelial layer and an underlying connective tissue layer constitutes an epithelial membrane. The principal epithelial membranes of the body are mucous membranes, serous membranes, and the cutaneous membrane, or skin (published in the next issue).

Mucous membranes line body surfaces opening directly to the exterior. Examples of mucous membranes include those lining the respiratory, digestive, urinary, and reproductive tracts. The epithelial cells of most mucous membranes secrete a thick, slimy material called mucus that keeps the membranes moist and soft.

A serous membrane lines a body cavity that does not open directly to the exterior, and it also covers the organs that lie within the cavity. The parietal layer is the portion attached to the cavity wall, and the visceral layer is the portion that covers and attaches to the organs inside these cavities. Serous fluid is secreted to lubricate all surfaces which allows the organs to easily glide over one another or to slide against the walls of the cavity.

Another type of membrane, a connective tissue membrane, contains only connective tissue and no epithelium. The synovial membranes lining the spaces between bones and joints that move are classified as connective tissue membranes.

Cells within the synovial membranes secrete synovial fluid. This fluid lubricates the ends of bones as they move at joints, nourishes the cartilage covering the bones, and removes microbes and debris from the joint cavity.