Lec 3

General Histology

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Connective Tissue Properties

All of the **connective tissue** of the body when taken together represents, by weight, the most abundant type of basic tissue in the body— even if it is epithelium that is mainly seen when clinically examining the body. Connective tissue is derived from the somites during prenatal development. The functions of connective tissue are as varied as its types; connective tissue is involved in support, attachment, packing, insulation, storage, transport, repair, and defense.

Connective Tissue Histology

Compared with epithelium, connective tissue is usually composed of fewer cells spaced farther apart and containing larger amounts of matrix between the cells (except for adipose connective tissue) (see Figure 1 in Lecture 3). Within connective tissue, the matrix is composed of intercellular substances and fibers.

Most connective tissue is renewable because its cells are capable of mitosis, and because most of its cells can even produce their own matrix of intercellular substance and fibers. In most cases, connective tissue is vascularized (except cartilage), each having its own blood supply.

Differing cells are found within the various types of connective tissue. The most common cell in all types of connective tissue is the **fibroblast (Figure 1)**.

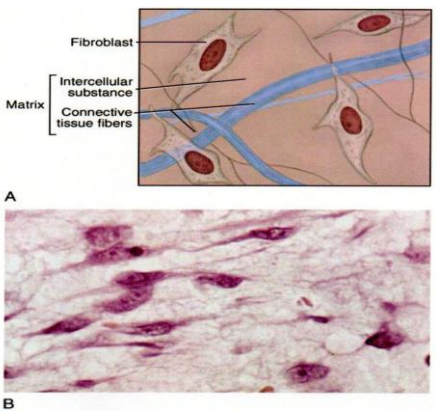

Figure 1. Fibroblasts. A, Diagram. B, Photomicrograph. The fibroblasts are within loose connective tissue, showing their spindle or fusiform shape. The cell forms the fibers of the connective tissue, as well as the intercellular substance between the tissue components.

Fibroblasts synthesize

Fibroblasts synthesize certain types of protein fibers and intercellular substances needed to sustain the connective tissue. They are flat, elongated spindle-shaped cells with cytoplasmic processes at each end. Subpopulations of fibroblasts may be possible within connective tissue. Fibroblasts are considered fixed cells in connective tissue because they do not leave the tissue to enter the blood as compared to cells with mobility, such as white blood cells.

Young fibroblasts that are actively engaged in the production of fibers and intercellular substances appear to have large amounts of cytoplasm, mitochondria, and rough endoplasmic reticulum. Fibroblasts can show aging and inactivity, with a reduction in cytoplasm, mitochondria, and rough endoplasmic reticulum, which is evident in the later stages of chronic advanced periodontal disease. If adequately stimulated during repair, however, fibroblasts may revert to a more active state.

Other cells found in connective tissue include migrated white blood cells from the blood supply, such as monocytes (macrophages), basophils (mast cells), lymphocytes (including plasma cells), and neutrophils.
Differing types of protein fibers are found in various types of connective tissue. The main connective tissue fiber type found in the body is **collagen fibers** (**Figure 2**).

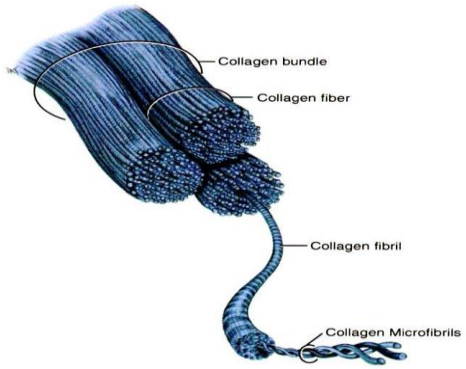

Figure 2. Collagen bundle that is composed of fibers, and smaller subunits—fibrils and microfibrils.

Over 29 types of collagen have been identified and described; however, over 90% of the collagen in the body or in fetal tissue is composed of only Types I-IV collagen (**Table 3**).

Table 3. Collagen Types

Main Types of Collagen	Features
Type I	The most common type is in the dermis of the skin, skeletal bone, tendons, and virtually all connective tissue of the bodyas well as lamina propria of the oral mucosa, dentin, pulp, periodontium, and the jawbones
Type II	In hyaline and elastic cartilage
Type III	In granulation tissue, produced quickly by young fibroblasts before tougher Type I synthesized, thus commonly found alongside Type I; the main componentof reticular fibers but also found in artery walls, skin, intestines, and uterus
Type IV	In basal laminae of the basement membrane, eye lens, and the filtration system of capillaries and the kidney's nephronglomeruli

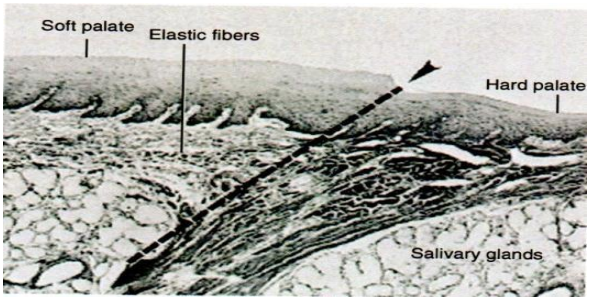

Figure 3. Photomicrograph of the junction of the soft palate and hard palate (arrow with dotted line), which is also a junction between a lining mucosa and a masticatory mucosa, as well as a junction between nonkeratinized epithelium and keratinized epithelium.

Connective Tissue Classification

One method of classifying connective tissue is according to texture, which can be soft, firm, rigid, or fluid in nature. Soft connective tissue includes the tissue found in the deeper layers of both the skin and oral mucosa, such as connective tissue proper. Firm connective tissue consists of different types of cartilage. The rigid, hard form of connective tissue consists of bone. Fluid connective tissue consists of blood with all its components and lymph.

Connective Tissue Proper

Soft connective tissue can be classified as loose, dense, or specialized. Both loose and dense types of connective tissue are found together in two adjoining layers as the **connective tissue proper**. The connective tissue proper is found deep in the epithelium and basement membrane, in the deeper layers of both the skin and oral mucosa. The connective tissue proper in the skin is the **dermis** and is found deep in the epidermis **(Figure 4)**.

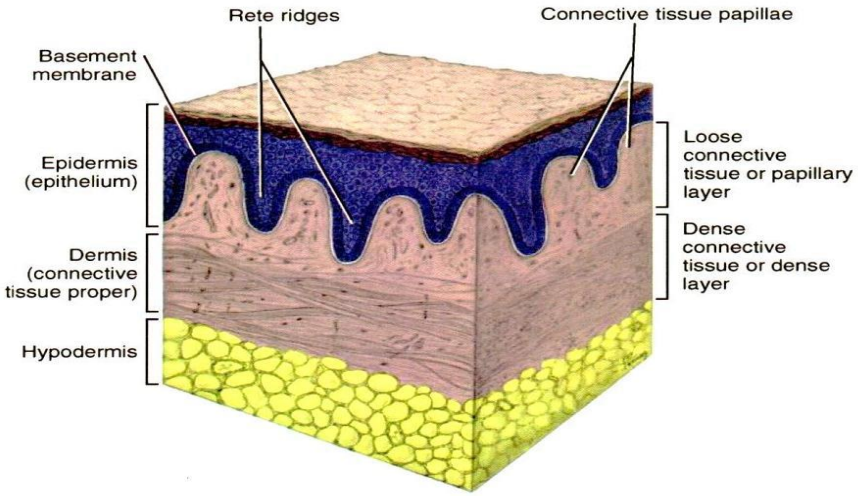

Figure 4. Skin with its epidermis and dermis layers. The hypodermis is present deep to the dermis. Note the interdigitating rete ridges of the epidermis with the connective tissue papillae of the dermis.

Even deeper to the dermis is the **hypodermis**, a subcutaneous tissue that is composed of loose connective tissue and adipose connective tissue, which is a specialized connective tissue, as well as glandular tissue, large blood vessels, and nerves. Cartilage, bone, and muscle can be present deep to the hypodermis of the skin, depending on the region of the body. In oral mucosa, the connective tissue proper is considered the lamina propria, and

the deeper connective tissue sometimes present is the submucosa, similar to the hypodermis in the skin (**Figure 5**).

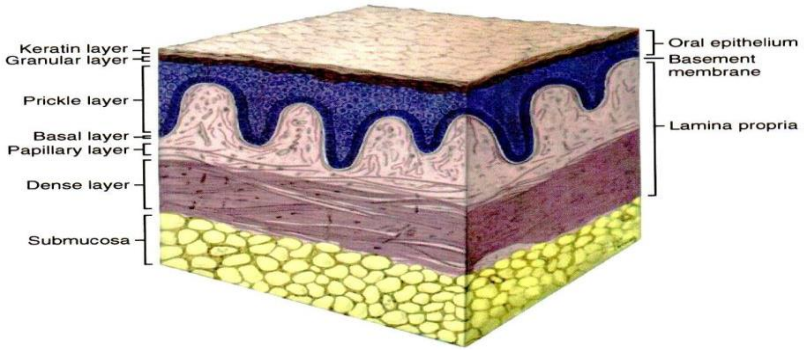

Figure 5. General histologic features of an oral mucosa composed of stratified squamous epithelium overlying lamina propria with a deeper submucosa present.

Loose Connective Tissue:

The superficial layer of both the dermis of the skin and lamina propria of the oral mucosa is composed of **loose connective tissue** (see Figure 4).

In both the dermis and lamina propria of oral mucosa, this layer of loose connective tissue is also considered the **papillary layer**. The papillary layer forms **connective tissue papillae**, which is interdigitated with the epithelial rete ridges (see Figure 4). This papillary layer has no overly prominent connective tissue element; all of the components of the papillary layer are present in equal amounts. Thus, equal amounts of cells, intercellular substance, fibers, and tissue fluid are in an irregular and loose arrangement. This loose layer of the connective tissue proper serves as protective padding for the deeper structures of the body.

Dense Connective Tissue:

Deep to the loose connective tissue is **dense connective tissue**, such as that found in the deepest layers of both 9 the dermis and lamina propria (see Figure 4). Similar to loose connective tissue, all of the same components of connective tissue are still present. However, in contrast to loose connective tissue, dense connective tissue is tightly packed with a regular arrangement, and it also consists mainly of protein fibers, which give this tissue its strength. The dense connective tissue in both the dermis and lamina propria is also considered the **dense layer** (or reticular layer). Thus, the dense layer is deep into the papillary layer in the connective tissue proper. In contrast, tendons, aponeuroses, and ligaments are a type of dense connective tissue that has a regular arrangement of strong, parallel collagen fibers with few fibroblasts or cells.

Connective Tissue Proper Regeneration, Turnover, and Repair

Turnover of both the connective tissue proper in skin or oral mucosa occurs as a result of the production of fibers and intercellular substance by the fibroblasts during regeneration (see Figure 5). Other types of cells can also undergo mitosis and create additional cells, such as certain white blood cells and endothelial cells. The overall turnover time for a connective tissue proper is slower than its adjoining epithelium; it also demonstrates individual variance from region to region. When injured, the connective tissue proper in both the skin and oral mucosa goes through stages of repair that are related to the events in the more superficial epithelium. After a clot forms and an inflammatory response is triggered with white blood cells, fibroblasts migrate to produce an immature connective tissue deep into the clot and a newly forming epithelial surface. [10] This immature connective tissue is considered **granulation tissue** and has few fibers and an increased amount of blood vessels. Granulation tissue can clinically appear as a redder, soft tissue that bleeds easily after injury or surgery, such as in the oral cavity after a tooth extraction. In addition, this tissue may become abundant, interfering with the repair process. Surgical removal of excess granulation tissue may be necessary to allow for optimum repair; this sometimes occurs after chronic advanced periodontal disease. Later, during the repair process, this temporary granulation tissue is replaced by paler and firmer scar tissue in the area. It is paler because scar tissue contains an increased amount of fibers and fewer blood vessels. The amount of scar tissue varies, depending on the type and size of the injury, amount of granulation tissue, and movement of tissue after injury. Interestingly, the skin shows more scar tissue production both clinically and microscopically after repair than does the oral mucosa. This difference may be based on differing developmental origins of the tissue producing differing types of fibroblasts and thus different types of fibers. The repair process can also be affected by hormones such as noted with systemic glucocorticoids (for example, cortisone) hinder repair by depressing the inflammatory reaction or by inhibiting the growth of fibroblasts, the production of collagen, and the formation of endothelial cells. Systemic stress, thyroidectomy, testosterone, adrenocorticotropic hormone, and large doses of estrogen suppress the formation of granulation tissue and impair healing. Progesterone increases and accelerates the vascularization of granulation

tissue and appears to increase the susceptibility of the gingival tissue to mechanical injury by causing dilation of the marginal vessels.

Specialized Connective Tissue Properties

Specialized connective tissue includes adipose, elastic, or reticular.

Adipose connective tissue is a fatty tissue that is found beneath the skin, around organs and various joints, and in regions of the oral cavity. Unlike most connective tissue, this type of connective tissue has cells packed tightly together with little or no matrix. After fibroblasts, the predominant type of cell found in this tissue is the adipocyte, which stores fat intracellularly.

Elastic connective tissue has a large number of elastic fibers in its matrix, which combine strength with elasticity, such as in the tissue of the vocal cords.

Reticular connective tissue is a delicate network of interwoven reticular fibers forming a supportive framework for blood vessels and internal organs.

Muscle Properties

The muscle in the body is part of the muscular system, and similar to connective tissue, most muscles are derived from somites. Each muscle shortens under neural control, causing soft tissue and bony structures of the body to move. The three types of muscle are classified according to structure, function, and innervation: skeletal, smooth, and cardiac.

Muscle Classification

Each type of **muscle** has its own type of action, which is the movement accomplished when the muscle cells contract. Smooth muscle and cardiac muscle are considered involuntary muscles because they are under 13 autonomic nervous system control (discussed next). Smooth muscles are located in organs, glands, and the linings of blood vessels. The cardiac muscle is in the wall of the heart (myocardium).

Skeletal muscles are considered voluntary muscles because they are under voluntary control, involving the somatic nervous system **(Figure 6)**.

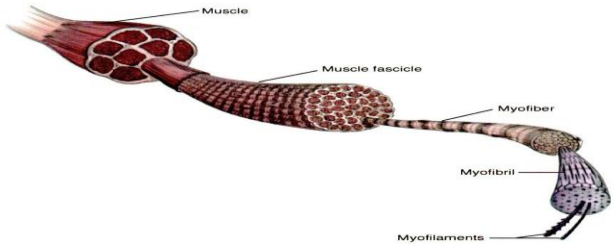

Figure 6. Skeletal muscle with its striations and is composed of smaller muscle bundles, fascicles, myofibers, myofibrils, and myofilaments.

All the major muscles of the body's appendages and trunk are skeletal muscles. Thus, skeletal muscles are usually attached to bones of the skeleton. Skeletal muscles also include the muscles of the facial expression, tongue, pharynx, and upper esophagus, as well as the muscles of mastication that assist the temporomandibular joint in the actions involved in mastication.

Skeletal Muscle Histology

Skeletal muscles are also called *striated muscles* because the muscle cells appear striped microscopically. Each muscle is composed of numerous muscle bundles, or fascicles, which then are composed of numerous muscle cells, or myofibers. Each *myofiber* extends the entire length of the muscle and is composed of smaller myofibrils surrounded by the other organelles of the cell. Each myofibril is composed of even smaller myofilaments.