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## The structure of the body – the Systems and organs

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The systems and organs of the body are composed of epithelial, connective, muscular and nervous tissues.

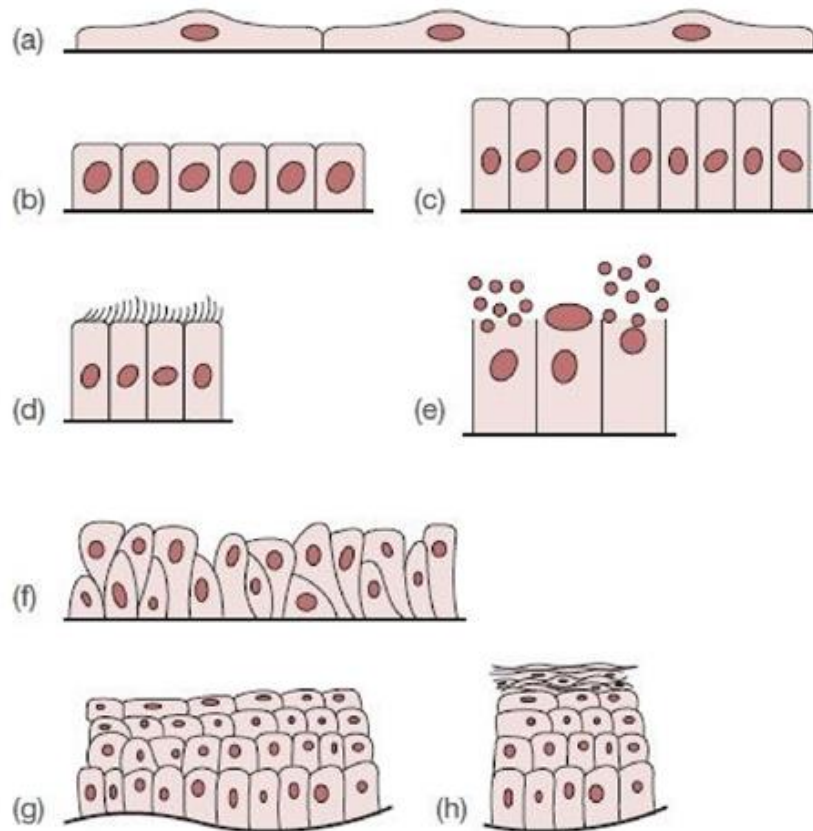
### EPITHELIAL TISSUE

Epithelium forms a protective covering over the internal and external surfaces of the body. It is derived from all three primitive embryonic layers. The ectoderm forms the skin; the mesoderm forms the pleura, pericardium and peritoneum; and the endoderm forms the endothelial lining of the blood vessels and gut.

Most glands are epithelial in origin, as they are formed by invagination of an epithelial surface. Epithelium is resistant to physical and chemical damage and the effects of dehydration. It can serve as a selective barrier and can be resistant to harmful metabolites, chemicals and bacteria. It is characterized by a minimal amount of intercellular substance and a tendency to form sheets of cells of one or more layers, having a capability of continuous replacement. It may be simple, transitional or stratified.

#### Simple epithelium

This consists of a single layer of cells on a basement membrane (Figs. 0.1a–e). It is described as squamous (pavement), cuboidal or columnar, depending on the shape of its cells. Squamous cells are found lining the alveoli of the lungs, the blood vessels (endothelium) and the serous cavities (mesothelium). Cuboidal cells line the ducts of many glands. Columnar cells are often ciliated and may be modified as mucus-forming goblet cells; they line much of the alimentary, respiratory and reproductive tracts. Mucus, a glycoprotein, accumulates in the cell and is discharged from its free (luminal) surface.



**Figure 0.1** Epithelial tissue: (a) squamous; (b) cuboidal; (c) columnar; (d) columnar ciliated; (e) columnar with goblet cells; (f) transitional; (g) stratified epithelium; (h) stratified squamous epithelium

### Transitional epithelium

This contains two or three layers of cells, most of which are attached to the basement membrane and are nucleated (**Fig. 0.1f**). It lines most of the urinary tract, is stretchable and does not desquamate. It contains few glands.

### Stratified squamous epithelium

This also has two or more layers of cells (**Figs. 0.1g,h**). Cells in contact with the basement membrane are columnar cells. The more superficial cells are flattened, and the surface cells have no nuclei (enucleate) and are continually being rubbed away (desquamated). This form of epithelium covers the exterior of the body, lines both ends of the alimentary tract and is particularly suited to areas exposed to wear and tear. In the upper respiratory tract the differing lengths of the columnar cells gives the appearance of a double layer, and this is known as pseudostratified columnar epithelium; it contains numerous mucous cells.

## Skin

This consists of two layers, an outer **epidermis** and an inner **dermis** (corium) (Fig. 0.2). The epidermis is composed of keratinized stratified squamous epithelium. **Hair follicles, sweat and sebaceous glands** and **nails** are modifications of the epidermis. The colour of the skin is determined by blood flow and melanocytes, the pigment-producing cells that lie in the basal layer of the epidermis. The scales on the surface of the skin consist mainly of **keratin**, a sulphur-containing fibrous protein largely responsible for the skin's protective and barrier properties.

The dermis is a layer of vascular connective tissue moulded tightly to the epidermis and merging in its deeper part with the subcutaneous tissues. Lying in the dermis are the coiled tubular sweat glands opening on to the skin surface and hair follicles, to each of which is attached an arrector pili muscle. The roots of the hairs and the sweat glands extend into the subcutaneous tissue.

## Mucous and serous membranes

These line the wet internal surfaces of the body and consist of two layers, an epithelium and a corium. The epithelium of mucous membranes is usually of a simple variety with many mucous or serous cells, but the urinary tract is lined by transitional epithelium, and the respiratory tract by pseudostratified columnar ciliated epithelium with mucous cells. The serous membranes line most of the closed body cavities. The corium underlies the epithelium and is composed of connective tissue. In the alimentary tract it contains a thin sheet of smooth muscle – the **muscularis mucosa**.

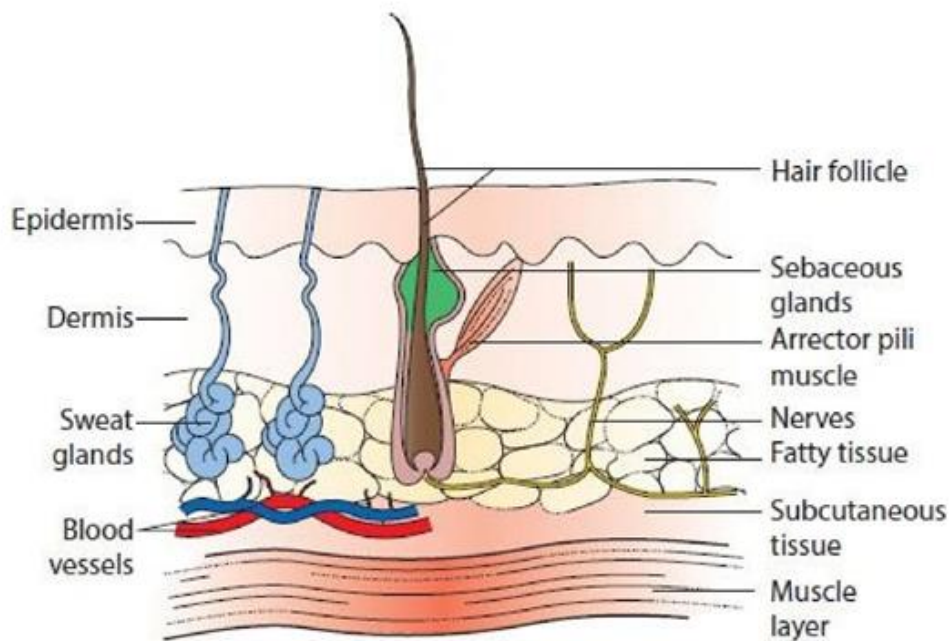


Figure 0.2 Diagram of a cross-section through the skin

## Glands

These are epithelial ingrowths modified to produce secretions. These secretions may pass on to the epithelial surface (**exocrine** glands) or into the bloodstream (**endocrine** glands). Exocrine glands may be unicellular (goblet) or multicellular. The latter may be simple (containing one duct) or compound (branched) where numerous, small ducts open into a single main duct. The secretory part of the gland may be long and thin (tubular), globular (acinar), oval (alveolar) or intermediate, e.g. tubuloalveolar. The secretions of the exocrine glands may be formed by disintegration of the whole cell (holocrine, e.g. sebaceous glands), disintegration of the free end of the cell (**apocrine**, e.g. mammary glands), or without cellular damage (merocrine or **epicrine**, e.g. most other glands). Most endocrine glands are of the last type.

If the duct of an exocrine gland becomes blocked and the gland continues to secrete, the fluid accumulates and a cyst is formed. A generalized enlargement of glands is termed adenopathy.

## CONNECTIVE TISSUE

This is characterized by having a large amount of intercellular substance. It forms areolar tissue, the packing material of the body, the supporting tissues (cartilage, bone) and blood ([Fig. 0.3](#)). Embryonic connective tissue is called mesenchyme.

### Areolar tissue

The intercellular substance is semisolid and composed of proteins and mucopolysaccharides. Three types of fibres are found: coarse **collagen** fibres, which are white (in bulk), flexible, inelastic and arranged in bundles; **elastic** fibres, which are yellowish (in bulk), less frequent and branching; and **reticular** fibres, which form a very fine silver-staining network throughout the tissues.

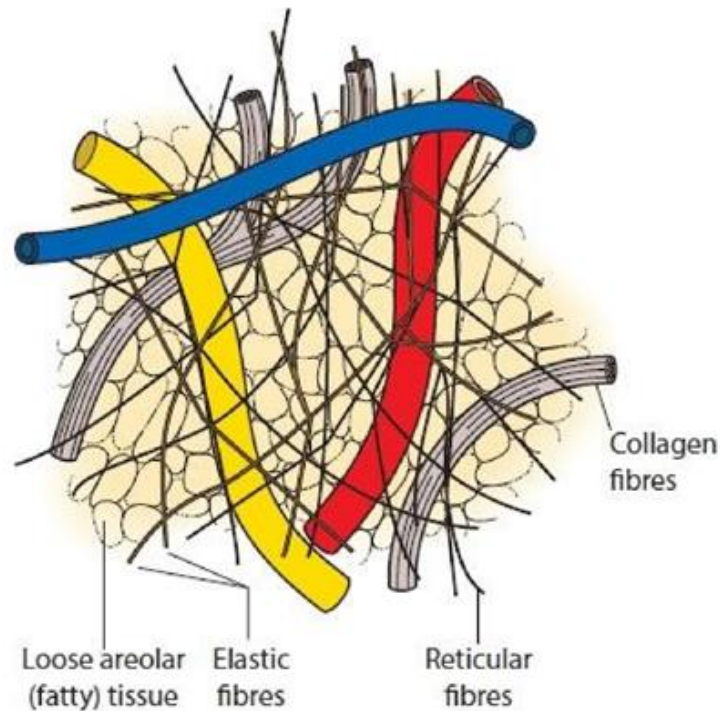


Figure 0.3 Connective tissue

The cells are of five main varieties: large, slender poorly staining fibroblasts, closely concerned with the production of the three types of tissue fibre; tissue macrophages, which are phagocytic and can engulf particulate matter; oval plasma cells with their cartwheel-like staining nucleus, concerned with antibody production; granular basophilic mast cells, concerned with histamine and heparin production; and the cyst-like fat-containing cells.

The relative amounts of cellular and intercellular substance vary throughout the body. Subcutaneous tissue contains a variable amount of fat and loose fibrous tissue. Superficially, fat is usually predominant, but more deeply the fibrous tissue forms a well-defined superficial fascial sheet connecting it to the deep fascia that invests the limbs and trunk. In other places condensations of non-elastic fibrous tissue form **ligaments**, **tendons** and **aponeuroses**, and **retinacula**. Ligaments are usually attached to the bones on each side of a joint, maintaining its stability; tendons join the muscles to the bones by blending with the periosteum; aponeuroses are thin flattened tendinous sheets through which muscles gain wider attachments. Retinacula are usually thickenings of the deep fascia related to joints.

## SUPPORTING TISSUE

### Cartilage

This is an avascular, firm tissue composed of cells (chondrocytes) in an abundant intercellular substance (matrix) (Fig. 0.4). It is formed from an overlying fibrous layer, the perichondrium, and classified,

according to its predominant fibres, into hyaline cartilage, fibrocartilage and yellow elastic cartilage.

- **Hyaline cartilage** contains many cells and a few fine collagen-like fibres, and is found in the rib cartilages and over most articular surfaces. It also forms the precursor in cartilaginous ossification.

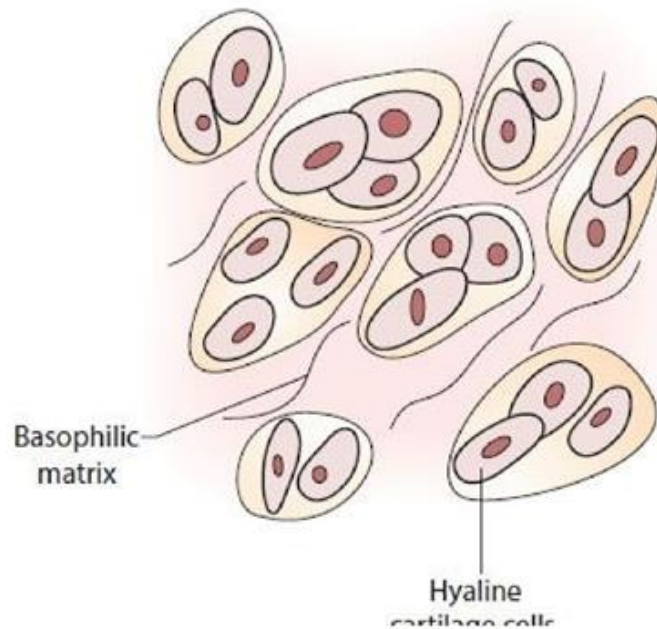


Figure 0.4 Hyaline cartilage

- **Fibrocartilage** contains many dense fibrous bundles and fewer cells, and is present in the intervertebral discs, over the articular surface of bones that ossify in membranes, e.g. the mandible, and in intra-articular cartilages, e.g. the menisci of the knee.
- **Yellow elastic cartilage** contains elastic fibres and is found in the auricular, epiglottic and the apices of the arytenoid cartilages of the head.

## Bone

This is a hard supporting tissue composed mainly of inorganic calcium salts impregnating a network of collagen fibres (Fig. 0.5). The basic unit, composed of concentric layers around a central vessel, is known as a **Haversian system**. The bone cells (osteocytes) lie within spaces (lacunae) between the layers and their processes pass into canaliculi in the bone. **Compact bone** is dense and strong and forms the outer part of most bones. The **cancellous** (spongy) bone within consists of a network of thin partitions (trabeculae) around intercommunicating spaces; the osteocytes lie within lacunae in the trabeculae. The outer surface of a bone is covered by a thick fibrous layer, the **periosteum**, many of the cells of which are the granular, bone-forming **osteoblasts**. These cells, when enclosed in the hard