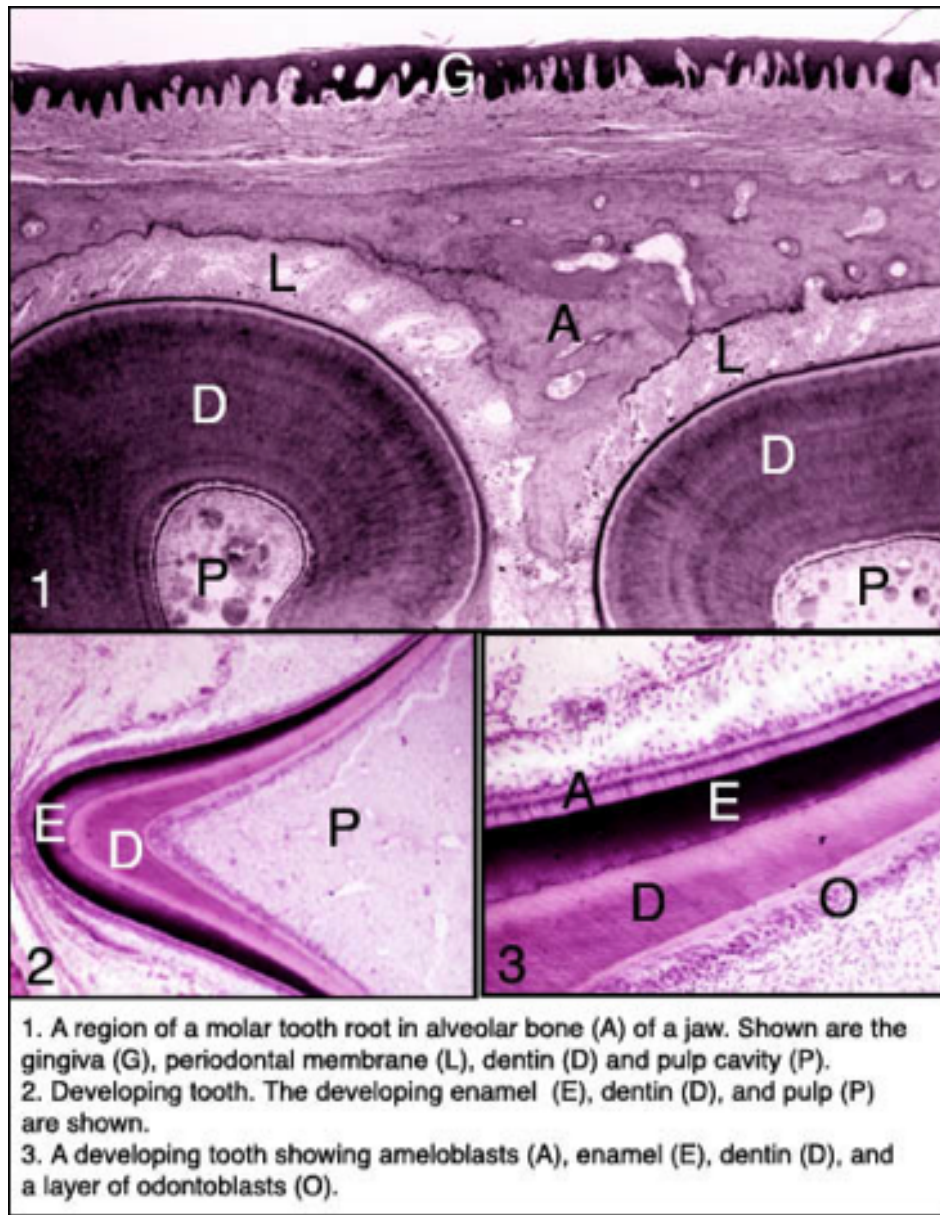


Teeth

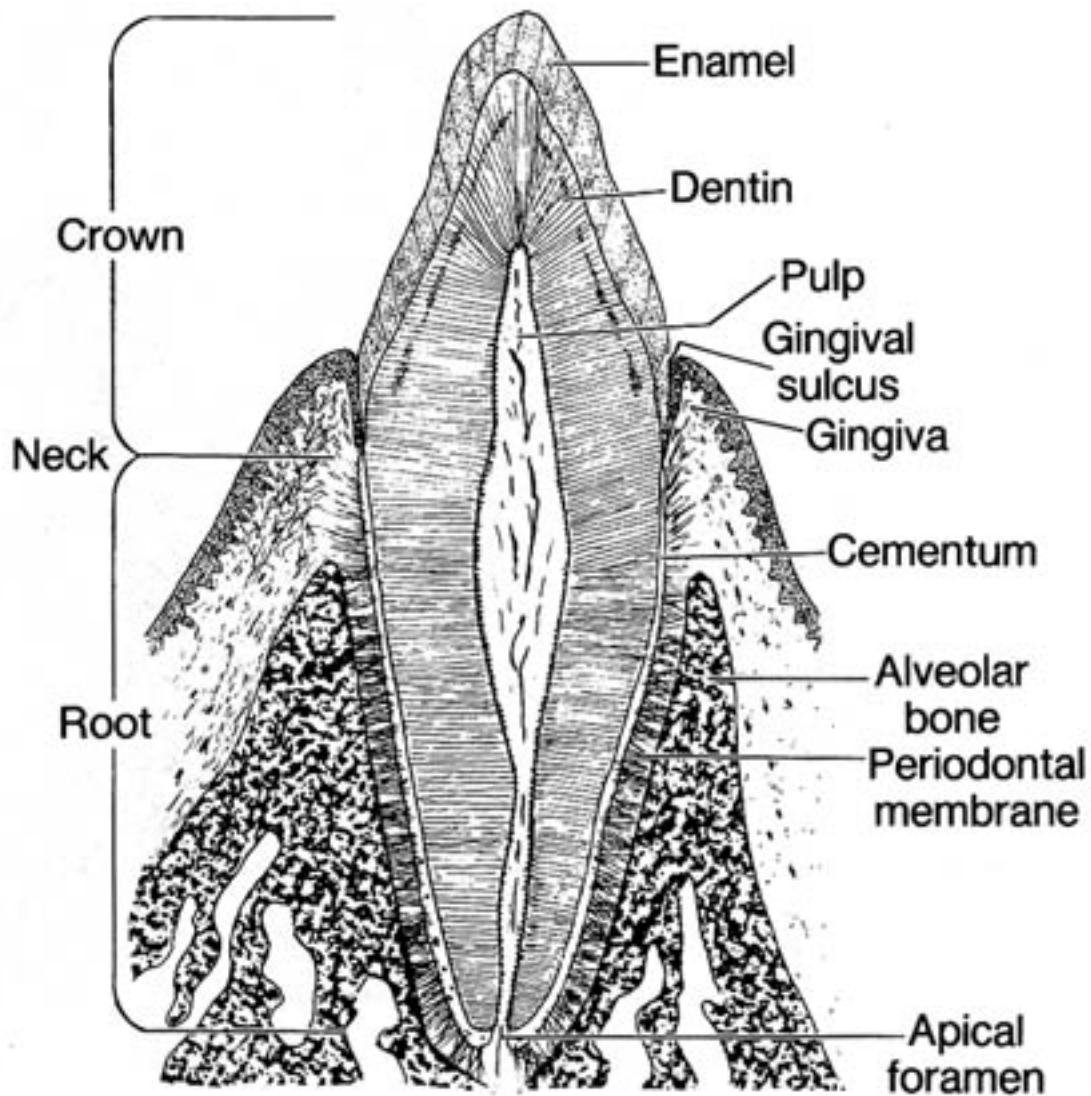


In humans, the teeth appear as two distinct sets: primary (deciduous) and permanent. Primary teeth erupt 6 to 8 months after birth and form a complete set of 20 by 2 years of age. They are shed between the sixth and thirteenth year and gradually are replaced by the permanent set of 32.

Structure

All teeth show the same histologic organization. Each has a crown and a root, and the point where the two meet is called the neck. The root fits into a socket (or alveolus) of the mandible or maxilla. Each tooth contains a small pulp cavity that corresponds in shape to the external form of the tooth. The pulp cavity communicates with the alveolar cavity and periodontal membrane through the apical foramen, a small opening at the tip of the root. The hard tissues

of the tooth consist of enamel, dentin, and cementum. Soft tissues associated with the tooth are the pulp, periodontal membrane, and gingiva.



A diagrammatic representation of the structures associated with a tooth.

Dentin

Dentin forms the bulk of the tooth and surrounds the pulp chamber. It is harder than compact bone and consists of 80% inorganic material and 20% organic substance. Most of the organic material is collagen, while the inorganic component is in the form of hydroxyapatite crystals. Dentin has a radially striated appearance due to numerous minute canals called dentinal tubules that pursue an S-shaped course as they extend from the pulp chamber to the dentinoenamel junction. The dentinal tubules contain fine cytoplasmic processes, called dentinal (Tomes') fibers, from a cell type known as the odontoblast. The thin layer of dentin

that immediately surrounds each dentinal tubule shows greater refringence than the remaining dentin and is called Neumann's sheath. The cell body of the odontoblast lies within the pulp cavity adjacent to the dentin. The odontoblast lays down the organic matrix of dentin (predentin) and is active throughout life so that there is a progressive narrowing of the pulp cavity with age. Predentin is rich in collagen, contains glycosaminoglycans, and is unmineralized. After its extracellular formation, predentin becomes mineralized. Some areas of dentin remain incompletely calcified and form the interglobular spaces. Dentin is sensitive to cold, pain, touch, and hydrogen ion concentration. Sensation is thought to be perceived by the processes of odontoblasts, which in turn transmit the sensory stimulation to adjacent nerves in the pulp chamber.

Enamel

Enamel covers the dentin of the crown and is the hardest substance of the body. It is acellular and consists primarily of calcium salts in the form of apatite crystals. Only 1% of the enamel substance is organic material. Enamel consists of thin rods called enamel prisms that lie perpendicular to the surface of the dentin and extend from the dentinoenamel junction to the surface of the tooth. Each prism, 6 to 8 μm in diameter, follows a spiraling, irregular course to the surface of the tooth. A small amount of organic matrix surrounds each enamel prism and is called the prismatic rod sheath. The organic matrix of enamel consists primarily of proteins called enamelin that bind to crystallites of the enamel prisms. Between the enamel prisms is the interprismatic substance, which also consists of apatite crystals in a small amount of organic matrix. Each enamel prism is the product of a single ameloblast, the enamel-producing cells that are lost during eruption of the tooth. Thus, new enamel cannot be formed after the tooth has erupted.

Cementum

Cementum covers the dentin of the tooth root. Nearest the neck of the tooth, the cementum is thin and lacks cells, forming the acellular cementum. The remainder, which covers the apex of the tooth root, contains cells, the cementocytes that lie in lacunae and are surrounded by a calcified matrix similar to that of bone. This type of cementum is referred to as cellular cementum. The organic matrix of cementum increases with age. Coarse bundles of collagen fibers penetrate the cementum as Sharpey's fibers, which anchor the root of the tooth to the surrounding alveolar bone of the socket.

Pulp

Pulp is the connective tissue that fills the pulp cavity. It contains numerous thin, collagenous fibers embedded in an abundant gelatinous ground substance. Stellate fibroblasts are the most prominent cells of the pulp, although mesenchymal cells, macrophages, and lymphocytes are found in limited numbers. The cell bodies of the odontoblasts also are found in the pulp, lining the perimeter of the pulp cavity immediately adjacent to the dentin. Blood vessels, lymphatics, and nerves enter and exit the pulp cavity through the apical foramen.

Periodontal Membrane

The periodontal membrane consists of thick bundles of collagen fibers that run between the cementum covering the root of the tooth and the surrounding alveolar bone. The fibers extend into the bone and cementum as Sharpey's fibers. The orientation of the fibers in the periodontal membrane varies at different levels in the alveolar socket. Although firmly attached to the surrounding alveolar bone, the fibers are not taut, and the tooth is able to move slightly in each direction. The periodontal membrane forms a suspensory ligament for the tooth. In addition to typical connective tissue cells, osteoblasts and osteoclasts may be found where the periodontal membrane enters the alveolar bone. The periodontal membrane has a rich vascular supply and is sensitive to pressure changes. Sensory nerve fibers linked to the mesencephalic nucleus of the fifth cranial nerve prevent excessive pressures from being exerted on the teeth during chewing and thereby prevents the crushing of one's own teeth.

Gingiva (Gum)

The gingiva (gum) surrounds each tooth like a collar and is attached to the periosteum of the underlying alveolar bone. Near the tooth, collagenous fibers of the gingival lamina propria blend with the uppermost fibers of the periodontal membrane. Some collagenous fibers extend from the lamina propria into the cervical (upper) cementum and constitute the gingival ligament, which provides a firm attachment to the tooth. The keratinized stratified squamous epithelium of the gingiva also is attached to the surface of the tooth and at this point forms the epithelial attachment cuff. Attachment of the cuff to the tooth is maintained by a thickened basal lamina and hemidesmosomes that seal off the dentogingival junction.

Tooth Development

Teeth have a dual origin: enamel arises from ectoderm; dentin, pulp, and cementum arise from mesoderm. Tooth development begins with the appearance of the dental lamina, a plate of epithelium on which knoblike swellings (enamel organs) appear at intervals. These give rise to enamel and also act as molds for tooth development. The enamel organs grow into the mesenchyme to form inverted, cuplike structures invaginated at the bases by dental papillae. The latter are condensations of mesenchyme that give rise to the dentin and pulp of teeth. The enamel organ forms a double-walled sac, of which the outer and inner walls differentiate into outer and inner enamel layers, respectively. Loosely arranged cells lie between the two layers and form the enamel pulp. Cells of the inner layer become *ameloblasts* and produce enamel prisms, beginning at the interface with the dental papillae. Mesenchymal cells of the papillae next to the inner dental layer enlarge and differentiate into odontoblasts. These form a single layer of columnar cells whose apices face the ameloblasts. *Odontoblasts* produce predentin that soon calcifies to become definitive dentin. Mesenchyme central to the odontoblasts forms the dental pulp. Dentin is the first of the hard tissues to appear in the tooth. Thereafter, both enamel and dentin are laid down, beginning at the apex and progressing toward the root. As the enamel and dentin layers thicken, the odontoblasts and ameloblasts gradually move away from each other. Ameloblasts migrate peripherally, remaining at the outer surface of the enamel, and eventually are lost from the tooth at eruption. Before they are lost, ameloblasts lay down an acellular layer called the enamel cuticle that covers the enamel adhering tightly to it. This cuticle may persist for a considerable time after teeth erupt and the ameloblasts are lost. Odontoblasts progress centrally into the pulp cavity where they persist. As they retreat, the

odontoblasts trail fine cytoplasmic processes that extend through the dentin to the dentinoenamel junction. The entrapped processes form the dentinal fibers contained in fine dentinal tubules.

Mesenchyme around the developing enamel organ differentiates into the loose connective tissue of the dentinal sac. Near the root, the inner cells of the sac become *cementoblasts* and cover the dentin with cementum. Cells at the exterior of the sac differentiate to produce the alveolar bone that surrounds each tooth. The connective tissue between the external and internal layers of the dental sac gives rise to the periodontal membrane. Before the tooth erupts, a small crater appears in the gingival epithelium and connective tissue, immediately above the crown. The crater, which expands to accommodate the tooth as it emerges, develops from focal pressure necrosis as the tooth grows upward, or by means of lytic activity of enzymes produced by the dental epithelium, or both.

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