Chapter 1

The Anatomy of Periodontal Tissues

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Introduction

This chapter includes a brief description of the characteristics of the normal periodontium. It is assumed that the reader has prior knowledge of oral embryology and histology. The periodontium (peri = around, odontos = tooth) comprises the following tissues (Fig. 1-1): (1) the *gingiva* (G), (2) the *periodontal ligament* (PL), (3) the *root cementum* (RC), and (4) the *alveolar bone* (AP). The alveolar bone consists of two components, the *alveolar bone proper* (ABP) and the alveolar process. The alveolar bone proper, also called "bundle bone", is continuous with the alveolar process and forms the thin bone plate that lines the alveolus of the tooth.

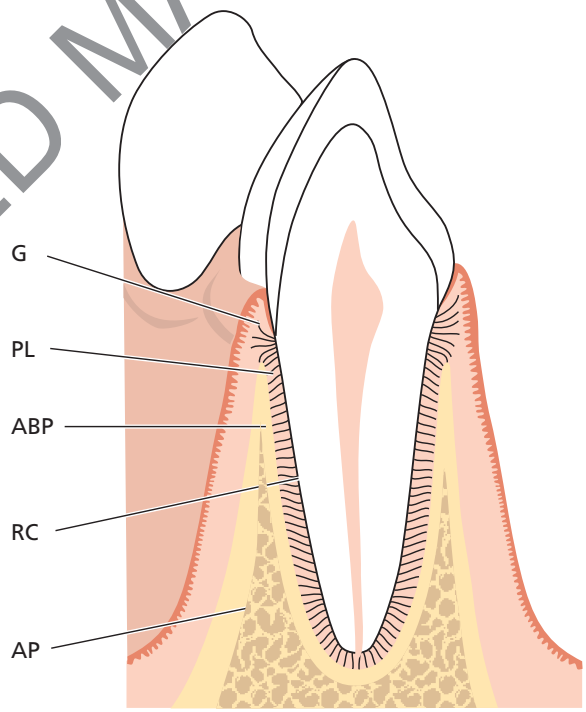

Fig. 1-1

The main function of the periodontium is to attach the tooth to the bone tissue of the jaws and to maintain the integrity of the surface of the masticatory mucosa of the oral cavity. The periodontium, also called "the attachment apparatus" or "the supporting tissues of the teeth", constitutes a developmental, biologic, and functional unit which undergoes certain changes with age and is, in addition, subjected to morphologic changes related to functional alterations and alterations in the oral environment.

The development of the periodontal tissues occurs during the development and formation of teeth. This process starts early in the embryonic phase when cells from the neural crest (from the neural tube of the embryo) migrate into the first branchial arch. In this position the neural crest cells form a band of *ectomesenchyme* beneath the epithelium of the stomatodeum (the primitive oral cavity). After the uncommitted neural crest cells have reached their location in the jaw space, the epithelium of the stomatodeum releases factors which initiate epithelial–ectomesenchymal interactions. Once these interactions have occurred, the ectomesenchyme takes the dominant role in the further development. Following the formation of the *dental lamina*, a series of processes are initiated (bud stage, cap stage, bell stage with root development) which result in the formation of a tooth and its surrounding periodontal tissues, including the alveolar bone proper. During the cap stage, condensation of ectomesenchymal cells appears in relation to the dental epithelium (the dental organ (DO)),

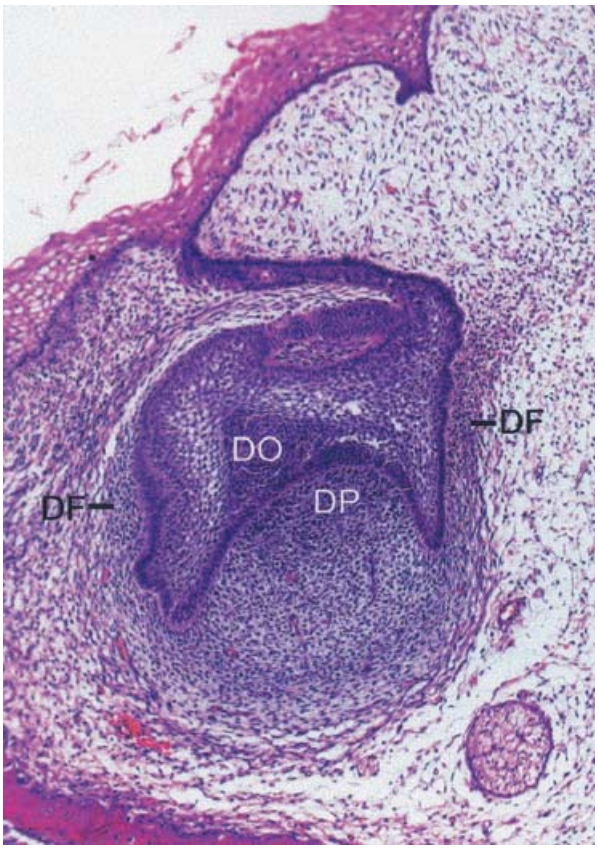

Fig. 1-2

forming the *dental papilla* (DP) that gives rise to the dentin and the pulp, and the *dental follicle* (DF) that gives rise to the periodontal supporting tissues (Fig. 1-2). The decisive role played by the ectomesenchyme in this process is further established by the fact that the tissue of the dental papilla apparently also determines the shape and form of the tooth.

If a tooth germ in the bell stage of development is dissected and transplanted to an ectopic site (e.g. the connective tissue or the anterior chamber of the eye), the tooth formation process continues. The crown and the root are formed, and the supporting structures, i.e. cementum, periodontal ligament, and a thin lamina of alveolar bone proper, also develop. Such experiments document that all information necessary for the formation of a tooth and its attachment apparatus obviously resides within the tissues of the dental organ and the surrounding ectomesenchyme. The dental organ is the formative organ of enamel, the dental papilla is the formative organ of the dentin–pulp complex, and the dental follicle is the formative organ of the attachment apparatus (the cementum, the periodontal ligament, and the alveolar bone proper).

The development of the root and the periodontal supporting tissues follows that of the crown. Epithelial cells of the external and internal dental epithelium (the dental organ) proliferate in an apical direction forming a double layer of cells named *Hertwig's epithelial root sheath* (RS). The odontoblasts (OB) forming the dentin of the root differentiate from ecto-

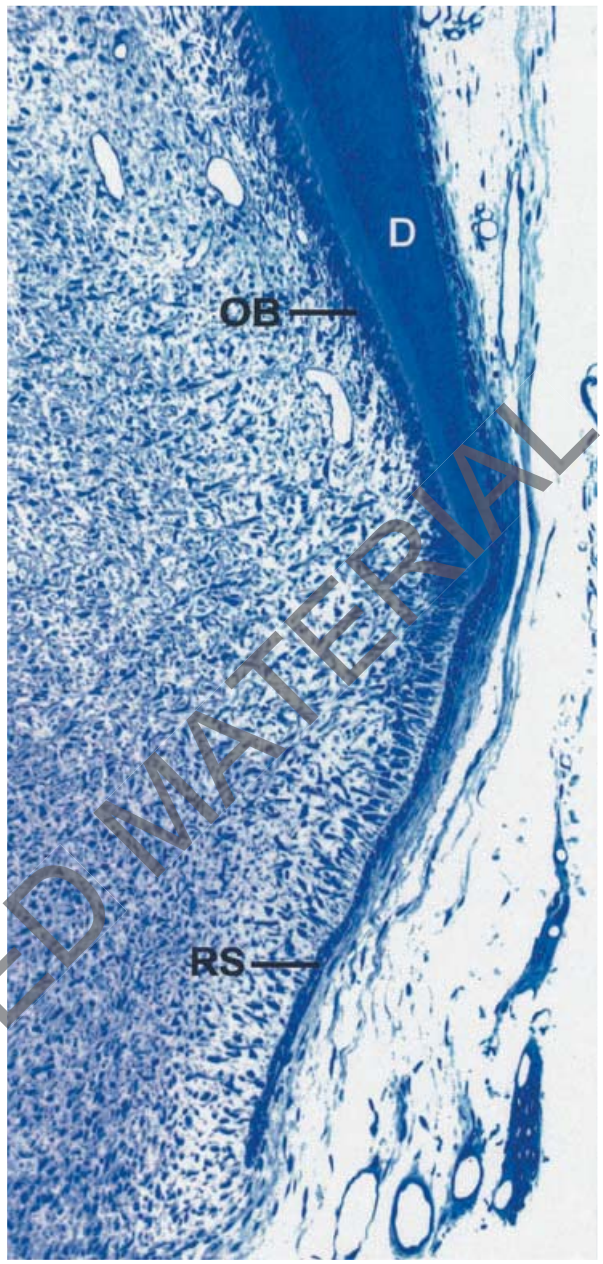

Fig. 1-3

mesenchymal cells in the dental papilla under inductive influence of the inner epithelial cells (Fig. 1-3). The dentin (D) continues to form in an apical direction producing the framework of the root. During formation of the root, the periodontal supporting tissues, including acellular cementum, develop. Some of the events in the cementogenesis are still unclear, but the following concept is gradually emerging.

At the start of dentin formation, the inner cells of Hertwig's epithelial root sheath synthesize and secrete enamel-related proteins, probably belonging to the amelogenin family. At the end of this period, the epithelial root sheath becomes fenestrated and ectomesenchymal cells from the dental follicle penetrate through these fenestrations and contact the root surface. The ectomesenchymal cells in contact with the enamel-related proteins differentiate into cementoblasts and start to form cementoid. This cementoid

Fig. 1-4

Fig. 1-5

represents the organic matrix of the cementum and consists of a ground substance and collagen fibers, which intermingle with collagen fibers in the not yet fully mineralized outer layer of the dentin. It is assumed that the cementum becomes firmly attached to the dentin through these fiber interactions. The formation of the cellular cementum, which covers the apical third of the dental roots, differs from that of acellular cementum in that some of the cementoblasts become embedded in the cementum.

The remaining parts of the periodontium are formed by ectomesenchymal cells from the dental follicle lateral to the cementum. Some of them differentiate into periodontal fibroblasts and form the fibers of the periodontal ligament while others become osteoblasts producing the alveolar bone proper in which the periodontal fibers are anchored. In other words, the primary alveolar wall is also an ectomesenchymal product. It is likely, but still not conclusively documented, that ectomesenchymal cells remain in the mature periodontium and take part in the turnover of this tissue.

Gingiva

Macroscopic anatomy

The oral mucosa (mucous membrane) is continuous with the skin of the lips and the mucosa of the soft palate and pharynx. The oral mucosa consists of (1) the *masticatory mucosa*, which includes the gingiva and the covering of the hard palate, (2) the *specialized mucosa*, which covers the dorsum of the tongue, and (3) the remaining part, called the *lining mucosa*.

Fig. 1-4 The gingiva is that part of the masticatory mucosa which covers the alveolar process and surrounds the cervical portion of the teeth. It consists of an epithelial layer and an underlying connective tissue layer called the *lamina propria*. The gingiva obtains its final shape and texture in conjunction with eruption of the teeth.

In the coronal direction the coral pink gingiva terminates in the *free gingival margin*, which has a scalloped outline. In the apical direction the gingiva is continuous with the loose, darker red *alveolar mucosa* (lining mucosa) from which the gingiva is separated by a usually easily recognizable borderline called