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ESSENTIALS OF PERIODONTOLOGY AND PERIODONTICS

2nd edition

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and
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Foreword

This is a book which I think you will enjoy. It has all the attractions of a good book, well written, well illustrated and well worth reading. By its title it claims to contain the essentials of the subject but it seems to me that it contains much more than the bare essentials and very little, if anything, has been omitted. It is therefore a sound book for undergraduate and postgraduate students to use. It will be ideal for general practitioners seeking to get an up to date view of this important part of modern dental practice. The book I find is conveniently divided into two sections, from chapter six to the end there is a full coverage of the clinical aspects and the preceding chapters deal with the basic pathology and the applied aspect of the biological sciences. The busy practitioner will probably first want to read onwards from chapter six to get the authors' views on clinical practice and treatment. This he can do and he will find what is advocated has been thoroughly tried out but he should not ignore the first five chapters. Let him settle in a comfortable chair and read these early chapters, he will find them rewarding. Sir William Osler said 'as your pathology so your treatment' this is still applicable to our practice to-day for we cannot adequately treat disease if we do not understand it. But to-day we have to prefix a phrase to this old aphorism and it is 'as your biology so your pathology' for modern biological sciences contribute so much to our understanding of disease that the scientific background to modern pathology has to be stated and this is one of the commendable features of this book.

This is the first text book produced by the members of staff of the Periodontal Department of the School of Dental Surgery, University of Edinburgh and for that reason it is very welcome. If the achievements of the department are anything to go by, the book will have much success.

JOHN BOYES

Preface

Something more than 40 per cent of teeth are extracted following caries, something less than 40 per cent following periodontal disease, and something more than 10 per cent for more bizarre reasons. The pattern of dental practice in Britain does not parallel the realities of tooth mortality and reorientation of the dental profession towards devoting a greater percentage of effort to control of periodontal disease is inevitable.

This book is about nonspecific periodontitis and its treatment. Periodontology is a rapidly developing science, and the practice of periodontics is to some extent still confused by the not inconsiderable mythology of the past. The object is to review the present state of knowledge of periodontology as we understand it and to relate this to a programme of patient treatment. The reference system shows the source of the information presented, and distinguishes mythology from what may be regarded as more responsible views.

The function of this book is to create an understanding of concepts and attitudes to the subject rather than didactic repetition of minutiae of techniques which are matters of personal preference, best learned at the chairside. For example, we have included a small section on technique of scaling largely to underline the need for a systematic and disciplined approach using suitable instruments. The particular system which is used, and the choice of instruments, are matters for the individual within the limitations of the general principles which are illustrated. Good technique automatically follows a clear understanding of the general principles underlying the procedure that the operator plans to carry out.

The book is written in fourteen chapters intended to present a logical sequence of information on which to base a programme of patient treatment. Each chapter, however, is designed to be largely complete in itself, and intelligible without necessarily having read those preceding. The first five chapters review the scientific aspect of the subject primarily for the convenience of present day undergraduate and postgraduate students. The clinical chapters are designed for the convenience of any student or dentist, and the system of treatment planning is that presently used by the Scottish Dental Estimates Board as a basis for estimates for periodontal treatment in the National Health Service.

We are indebted to the previous Heads of the Department of Periodontology in the Edinburgh Dental School, Dr J.W. Galloway and Professor G.S. Beagrie with whom we have worked during our years as students and as members of the staff and to Professors John Boyes and John Mansbridge for their constant encouragement. We have received much valuable advice and guidance during preparation of the manuscript from our self-chosen readers, Professor W.D. McHugh of the Chair of Dental Health, University of Dundee, Mr A.J.W. McKendrick, Senior Lecturer in the Department of Periodontology, University of Dundee, and Docent Jan Egelberg

of the School of Dentistry, Malmö, Sweden. It must be made clear, however, that responsibility for the views expressed in this book lies entirely with us, and that the readers are in no way committed.

We thank Miss Mary Benstead, sometime Medical Artist in the Edinburgh Dental School for the drawings so signed; Mr Alex. Hunter, M.B.E. Chief Technician in the Edinburgh Dental School, Mr Robert Renton and Mr Ian Goddard for the quality of many of the photographs taken over the years: Mrs Jean Carus, Miss Edna Miller, Mrs C. Weir and other Secretaries who have assisted in preparation of the manuscript: Miss Anne Taylor for her assistance with the index.

T.M.

As a rule disease as it stalks through
the land cannot keep pace with the
incurable vice of scribbling about it.

John Mayou de Rachitide, 1668

G.C.

Oh that one would hear me! behold, my desire is,
that the Almighty would answer me and
that mine adversary had written a book.

Job 31:35

Preface to Second Edition

The format of this book remains similar to that of the first edition. Each chapter has been updated in the areas where it seemed that significant information had emerged during the six years since the original manuscript was prepared, and a short review of the epidemiology of gingivitis and periodontitis forms an additional chapter.

Laboratory studies have now confirmed the significance of immunologic mechanisms in periodontitis and what was to some extent 'crystal ball gazing' at the time of the first edition is now a reality to be appreciated at least to some degree by all undergraduates, post-graduates and practitioners of all fields of dentistry. The chapter on aetiology of periodontitis has been extended by some 30,000 words on the ecology of plaque, the basic principles of immunology, the host response to plaque and the mechanisms of tissue destruction in periodontitis.

We thank Miss Jenny Mitchell, sometime medical artist in the Edinburgh Dental School, for the drawings additional to those present in the first edition; Mr Alex Hunter, M.B.E. Chief Technician in the Edinburgh Dental School and Mr Ian Goddard for the photographs: Miss Anne Brennan, Miss Mary Ferguson and Mrs C. Weir for the preparation of the manuscript and Miss Anne Taylor for her assistance with the reference system.

T.M.

'Obscurus fio'
It is when I am struggling to be brief that I become unintelligible.

Horace. Ars Poetica v 25

G.C.

'Sero in periculis est consilium quaerere'
'It is too late to seek advice after you have run into danger.'

Publilius Syrus. Sententiae No. 684
c43 BC

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CHAPTER 1

The periodontium

The supporting apparatus of the teeth, as defined by the term periodontium, consists of bone, cementum, periodontal membrane, and the investing sheath of the gingivae and oral mucosa. The adult tooth protrudes into the mouth through a cuff of mucous membrane closely adapted to the tooth surface, which acts as a seal between the environment of the clinical crown of the tooth, the mouth, and the environment of the root of the tooth, the epithelial and connective tissue elements of the supporting tissues (fig. 1.1). In the young adult, where the epithelial cuff is related entirely to enamel, an epithelial structure in origin, the mouth can be considered to be covered by a continuous epithelial sheath. With advancing age, the cuff

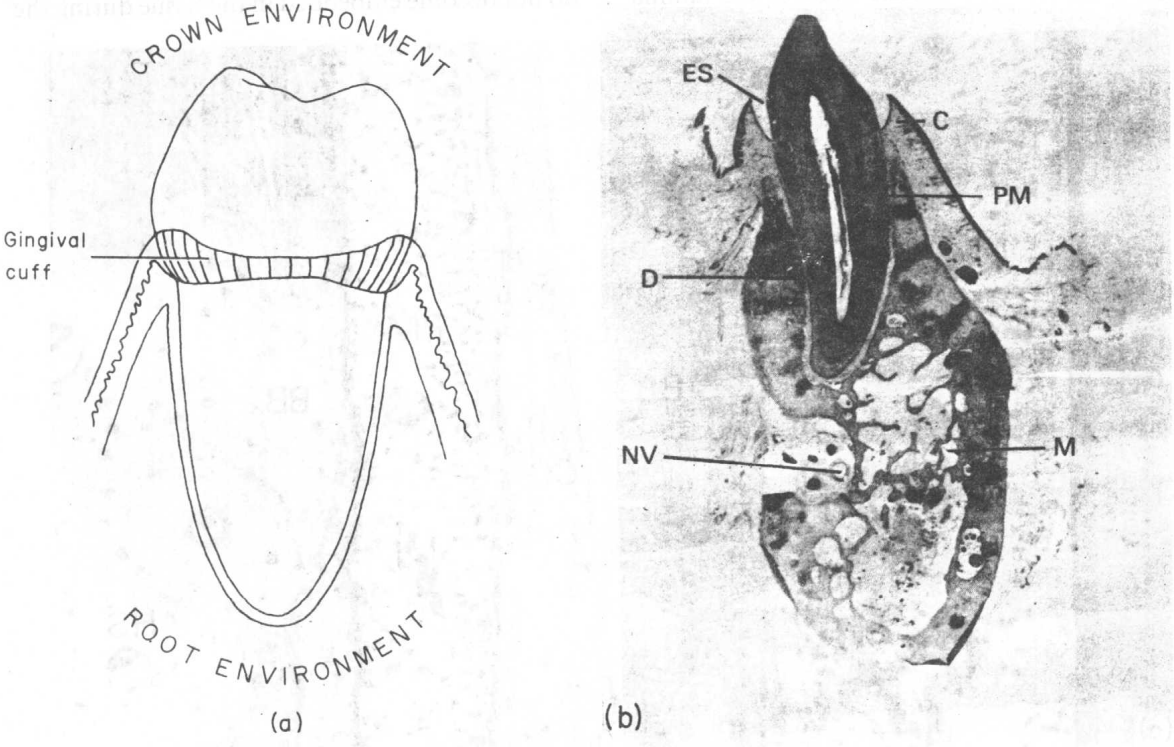

FIG. 1.1. (a) The tooth protrudes into the mouth through a cuff of mucous membrane which acts as a seal between the environment of the crown and the environment of the root. (b) Decalcified buccolingual section of a dog mandibular premolar; C, cuff; D, dentine of root; ES, enamel space; M, mandible; NV, inferior dental nerves and vessels; PM, periodontal membrane.

may become related to cementum, which is mesenchymal in origin, and the unique situation is established where the overall epithelial covering of the body is breached by the tooth. The connective tissues around the root of the tooth are at risk to the hazards of the external environment, probably to a greater degree than in any other area of the body.

BONE

Alveolar bone differs in no way from bone elsewhere in the body, with the exception of its dependence on the presence of the teeth. It is a transient tissue whose principal function is the support of teeth, and following their loss it is gradually resorbed. The bone lining the socket adjacent to the roots of the teeth is dense 'bundle' bone, called the lamina dura, into which collagen bundles of the periodontium are inserted; they are described as Sharpey's fibres (fig. 1.2a). The thin bundle bone of the lamina dura is pierced by many small holes (Volkman canals) which act as channels for the vessels and nerves of the periodontium (fig. 1.3a). It is continuous with the buccal and lingual cortical plates at the crest of the ridge (fig. 1.3b). The bone between the external cortical plates and the cribriform lamina dura is of the cancellous type. Bone is a highly adaptable tissue, and there is a continuous process of resorption and remodelling in progress. The position and shape of the alveolar crestal bone depends upon the degree of eruption, angulation and position of the related teeth [1].

CEMENTUM

Cementum is a hard, calcified connective tissue arranged in layers around the root of the tooth [2 & 3], into which the Sharpey's fibres are inserted (fig. 1.4a). The cementum of the cervical two-thirds of the root is a thin, acellular, laminated tissue laid down by cementoblasts, which do not become embedded in the tissue during the

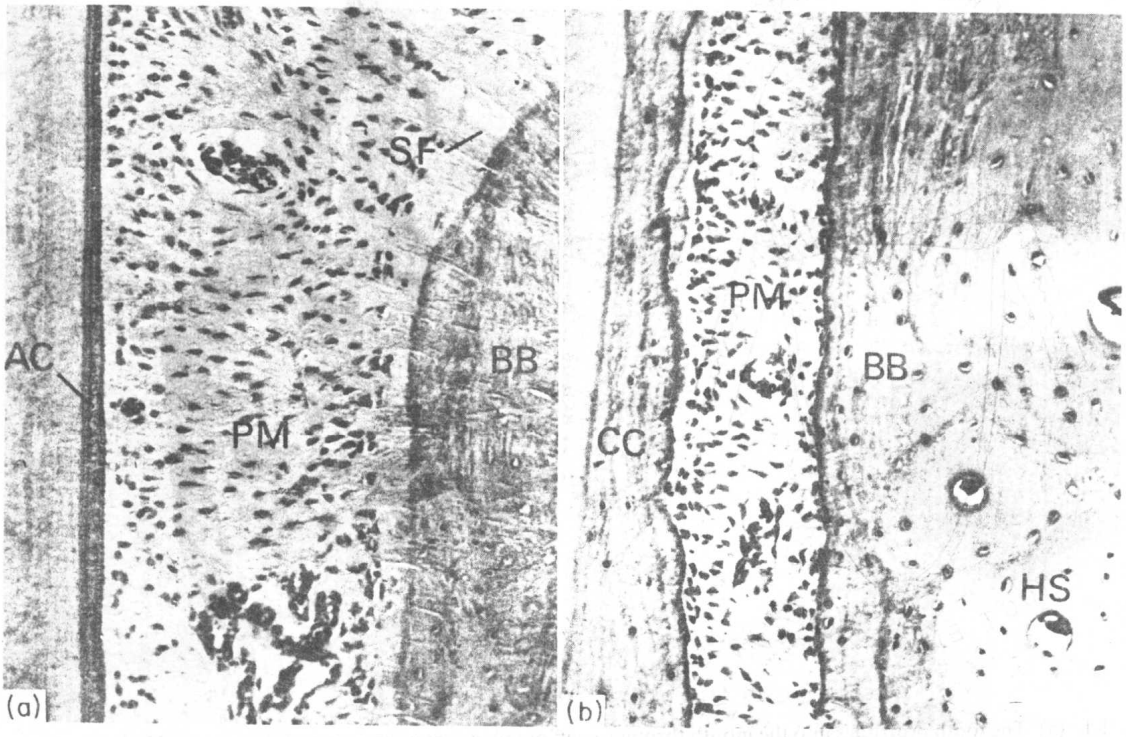

FIG. 1.2. Buccolingual sections through root of tooth, periodontal membrane and alveolar bone; (a) cervical area and (b) apical third of root. AC, acellular cementum; BB, bundle bone of lamina dura; CC, cellular cementum; HS, haversian systems; PM, periodontal membrane; SF, Sharpey's fibres.

apposition of further layers (figs. 1.2a & 1.4b). The cementum of the apical one-third of the root is cellular in character and is broadly comparable to bone in its general structure (fig. 1.2b). Cementum formation is probably a continuous process throughout life [4 & 5], the rate of formation being partly governed by the degree of function of the tooth. It does not, however, have the capacity for resorption and remodelling possessed by bone.

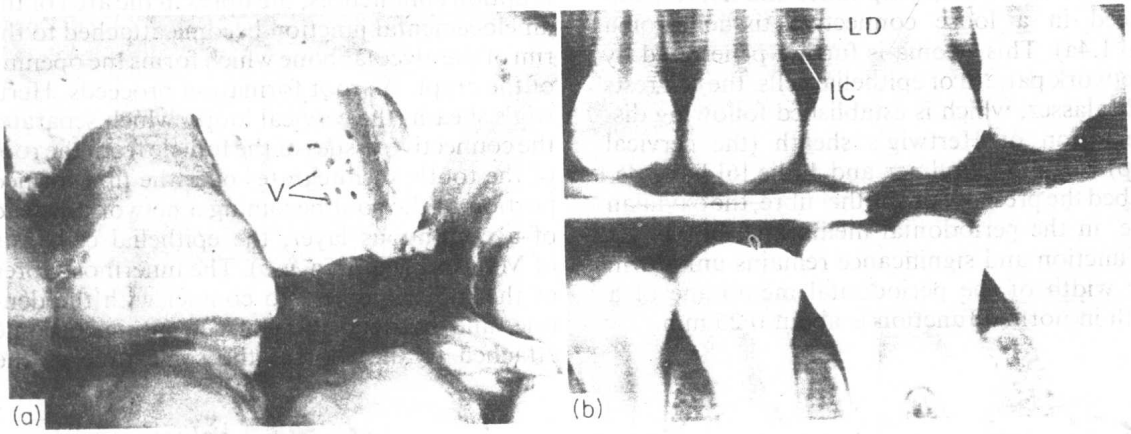

FIG. 1.3. (a) Skull socket, cribriform plate; V, Volkman canals. (b) Bitewing normal bone. The lamina dura (LD) of adjacent sockets appears to be continuous across the interdental crests (IC), courtesy of Mr A.R. Bradshaw.

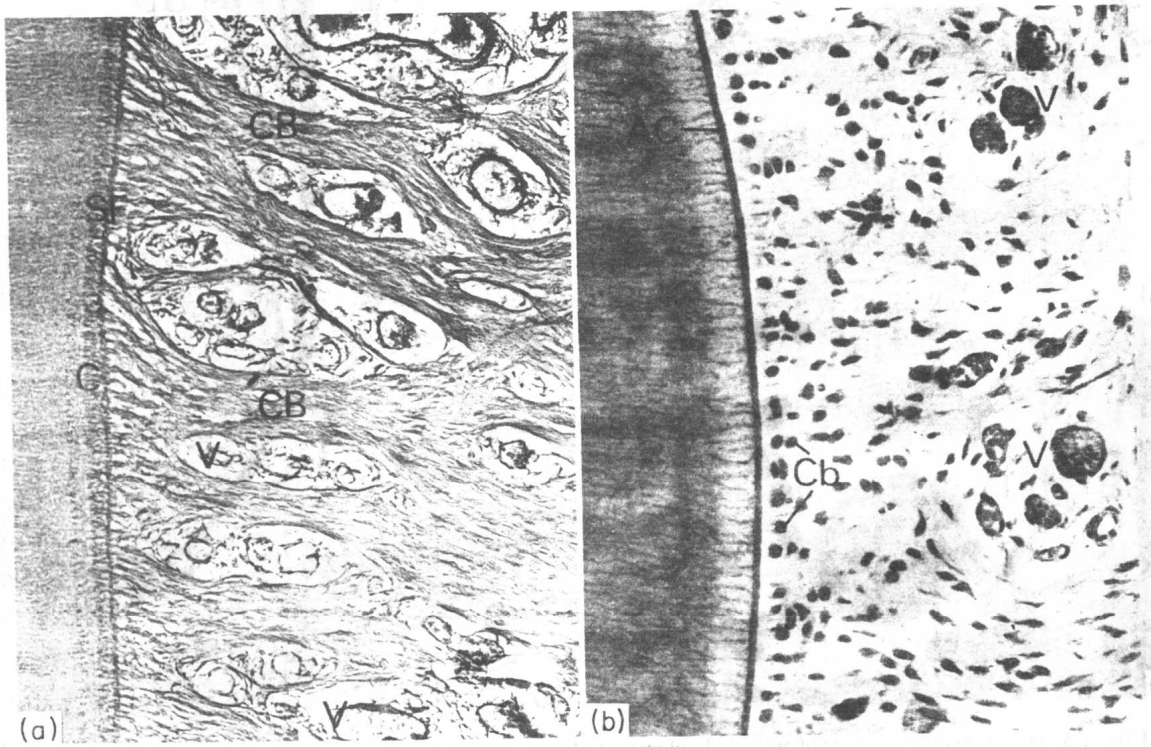

FIG. 1.4. Periodontal membrane. (a) Longitudinal section, silver impregnation; CB, collagen bundles; V, vessels; C, cementum; SF, Sharpey's fibres inserted into cementum. (b) Transverse section, haematoxylin and eosin; Cb, cementoblasts; AC, acellular cementum; V, vessels.

PERIODONTAL MEMBRANE

Periodontal membrane consists essentially of groups of collagenous connective tissue fibres that are formed by fibroblasts. Between these bundles run vessels, lymphatics and nerves, embraced in a loose connective tissue stroma (fig. 1.4a). This stroma is further penetrated by a network pattern of epithelial cells, the cell rests of Malassez, which is established following disintegration of Hertwig's sheath (the cervical loop) (fig. 1.5). Fullmer and Lillie [6] have described the presence of another fibre, the oxytalan fibre, in the periodontal membrane, but as yet its function and significance remains unknown. The width of the periodontal membrane of a tooth in normal function is about 0·25 mm.

DEVELOPMENT OF PERIODONTIUM

Before the onset of tooth eruption, the outer wall of the tooth follicle is in contact with, but not attached to, the bone of the crypt. When eruption commences, the fibres in the area of the amelocemental junction become attached to the rim of the alveolar bone which forms the opening of the crypt. As root formation proceeds, Hertwig's sheath (the cervical loop), which separates the connective tissues of the follicle from the root of the tooth, disintegrates over the first formed portion of the root becoming a network instead of a continuous layer, the epithelial cell rests of Malassez (fig. 1.5a & b). The innermost fibres of the follicle come into contact with the dentine, and by deposition of cementum, become attached to the root at the same time as the

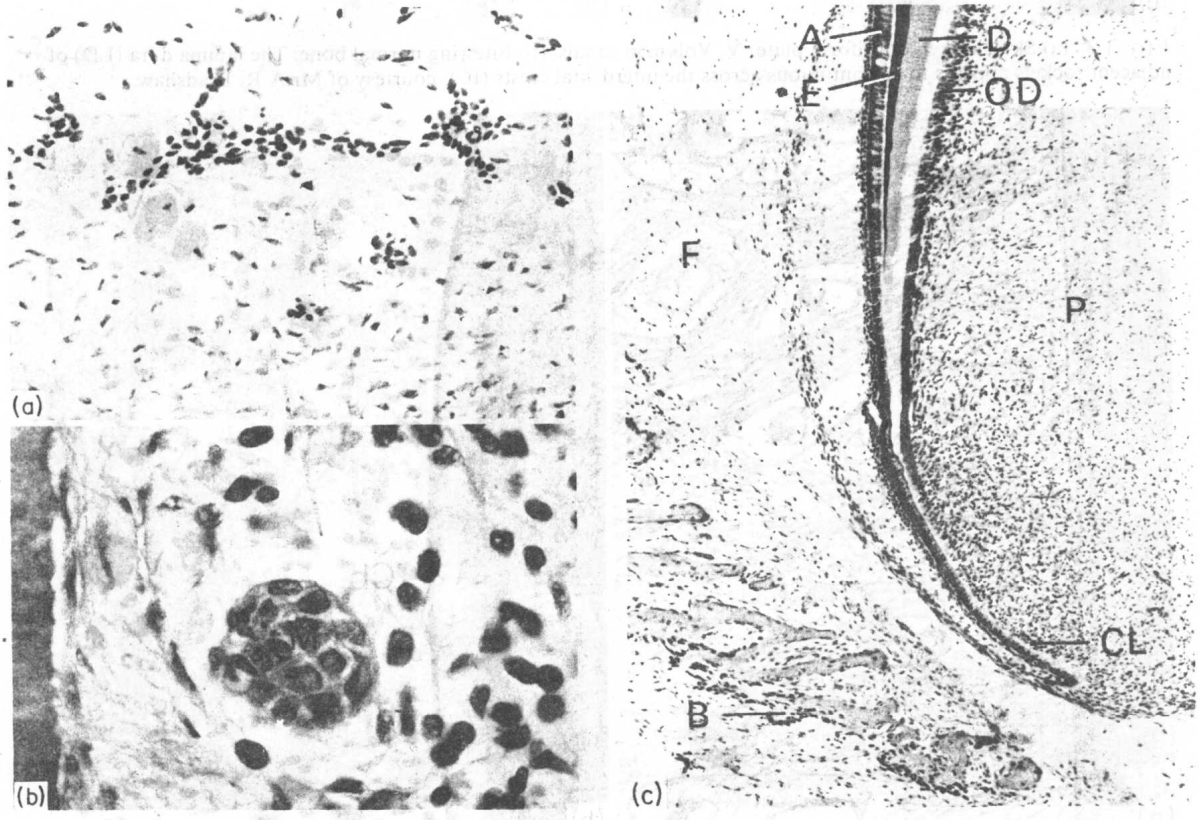

FIG. 1.5. (a) The network pattern of epithelial cell rests of Malassez which becomes established in the connective tissue stroma following disintegration of Hertwig's sheath (the cervical loop, fig. 1.5). (b) Epithelial cell rest of Malassez (M), high power. (c) Developing tooth in crypt; CL, cervical loop; P, pulp; F, follicle; B, bone crypt; D, dentine; OD, odontoblasts; E, enamel; A, ameloblasts.

outermost fibres of the follicle are becoming attached to the wall of the developing socket. In this way the follicle, which is for the greater part of its development free of attachment to bone, becomes the periodontal membrane.

The principal bundles of fibres in the periodontal membrane are frequently described as:

(1) the alveolar crestal fibres, a condensation of fibre bundles which run from the cervical area of the root to the crest of the alveolar bone;

(2) the horizontal fibres, which run at right angles to the tooth and to the alveolar bone;

(3) the oblique fibres, which run in an apical direction from alveolar bone to cementum.

There is some question as to what extent such discrete groups of collagen fibres exist *in vivo*, since the histological appearance is partly governed by the process of tissue fixation and subsequent procedures involved in the preparation of tissue for microscopy.

The collagen fibres of the periodontal membrane show a moderately high rate of amino acid turnover [7], particularly on the alveolar bone side [8], and the tissue as a whole is capable of a high degree of functional adaptation (chap. 12).

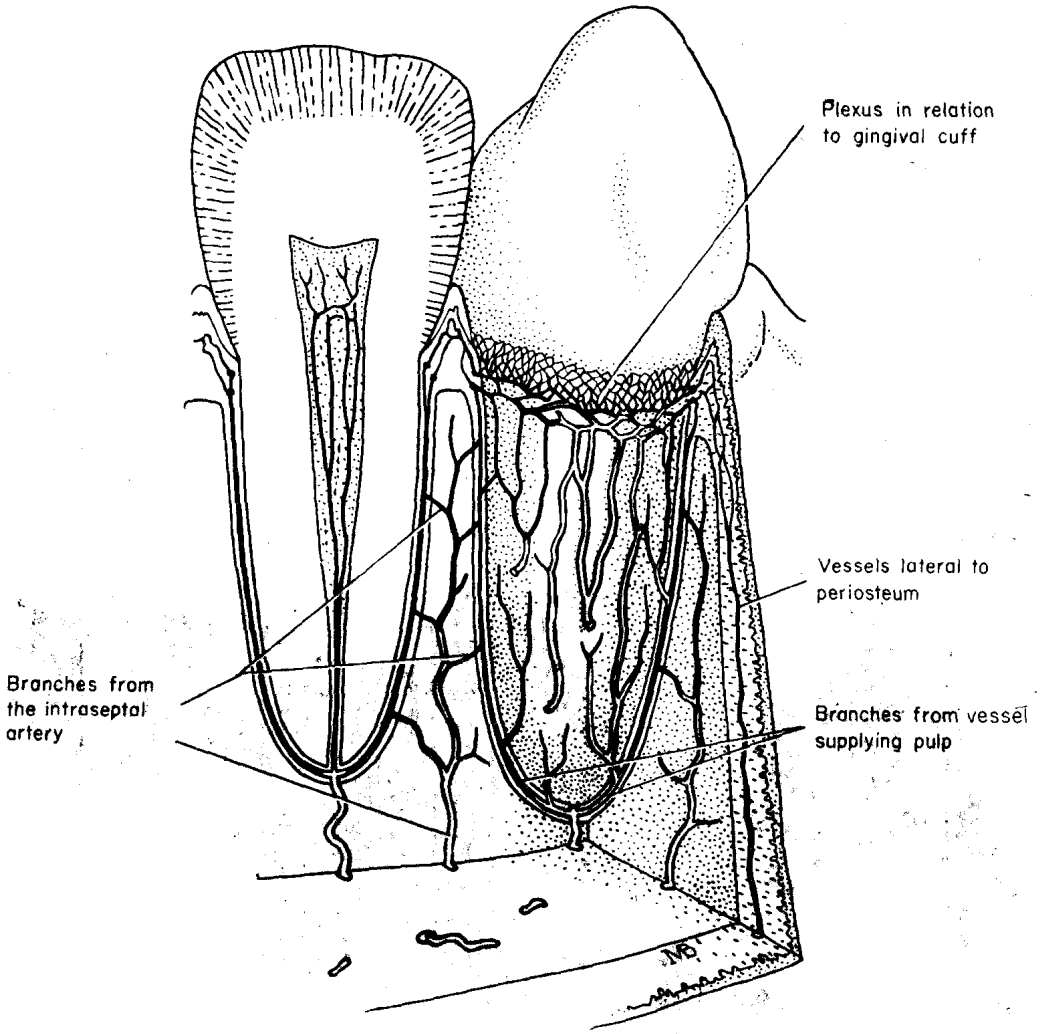

FIG. 1.6. Blood supply to periodontium. Three sources: (a) branches from apical vessels, which form a network between the root and alveolar bone, (b) branches from intraseptal vessels, (c) branches from vessels lateral to the periosteum.

BLOOD SUPPLY TO THE PERIODONTIUM

The blood supply to the periodontium is delivered from three sources [9, 10 & 11] (fig. 1.6):

(1) apical vessels which give off branches to the periodontal membrane before supplying the pulp;

(2) branches from the intraseptal arteries which penetrate the lamina dura at all levels and form an anastomosis between the periodontal vessels of apical origin and the vessels of the Haversian system of the alveolar bone;

(3) branches lying lateral to the periosteum supplying the gingival tissue and oral mucous membrane which anastomose with the vessels of the periodontal membrane forming a well-defined vascular plexus above the marginal ligament (figs 1.6 & 1.7a & b). The marginal ligament is formed by collagen fibres in the region between the amelocemental junction and the crest of the alveolar bone, and it thus lies immediately deep to the gingival cuff (fig. 1.13).

The entire vascular system is such that the root of the tooth is in a fluid environment, where the fluid in the vessels of gingivae and periodontium is in continuity with the vascular reservoir in bone [12]. Shift of fluid in the system may contribute to the ability of the tooth to withstand stress in normal and abnormal function. The lymphatic system probably has a similar distribution to the blood vessels, although an adequate description is not present in the dental literature. It may also contribute to the fluid buffer system of the root.

NERVE SUPPLY TO THE PERIODONTIUM

PERIODONTAL MEMBRANE

The nerve supply to the periodontal membrane is derived from two sources [13]. One group of fibres arises from the dental nerve as it passes through the alveolar plate prior to entering the apical foramen of the tooth. This group runs cervically and gives off branches which form a network within the membrane. The second main source of fibres is branches from the intra-alveolar nerve, which ascend through the bone toward the alveolar crest. The lateral nerves pass through the cribriform plate of the socket to end in the periodontal membrane. The branches terminate as a fine arborization within the periodontal membrane [14].

GINGIVAL INNERVATION

The terminal branches of the nerve supplying the periodontal membrane also supply the interdental area of the gingivae, whilst branches from the buccal, lingual, and palatal nerves supply the free and attached gingivae. The filaments penetrate the submucosa where further branching occurs; most of the nerves terminate as a fine

FIG. 1.7. India ink perfusion of chronically inflamed marginal gingivae of dog to show blood vessels. (a) Buccolingual section showing vascular plexus (P) deep to cuff epithelium (CE) and superficial to the marginal ligament (fig. 1.13). (b) Mesiodistal section showing the extreme complexity of the vascular plexus underlying the cuff epithelium. Courtesy of Dr J. Egelberg and the *Journal of Periodontal Research*.

network at the dermoepidermal junction. Intra-epithelial nerves have been demonstrated to course from the dermal papillae towards the surface of the epithelium, ending in a small bulb like structure [15]. Although many filaments throughout the gingivae appear to have no specialized ending, both Meissner and Krause corpuscles have been described [16].

THE INVESTING SHEATH

The mucosal covering of the attachment apparatus can be divided into several parts, the free gingivae, the attached gingivae and the reflected mucosa (fig. 1.8a & b), which develop from the oral mucous membrane, and the epithelium of the gingival cuff, which at the time of eruption at least is in part enamel organ epithelium in origin [17] (fig. 1.8c & d).

GINGIVAE

The gingivae is that mucous membrane which extends from the cervical region of the tooth to the alveolar mucosa. A potential space, the gingival sulcus, is formed where the marginal gingivae lies against the tooth.

In health the gingivae is coral pink in colour although this may vary to some extent with the amount of pigment present. The tissue is usually

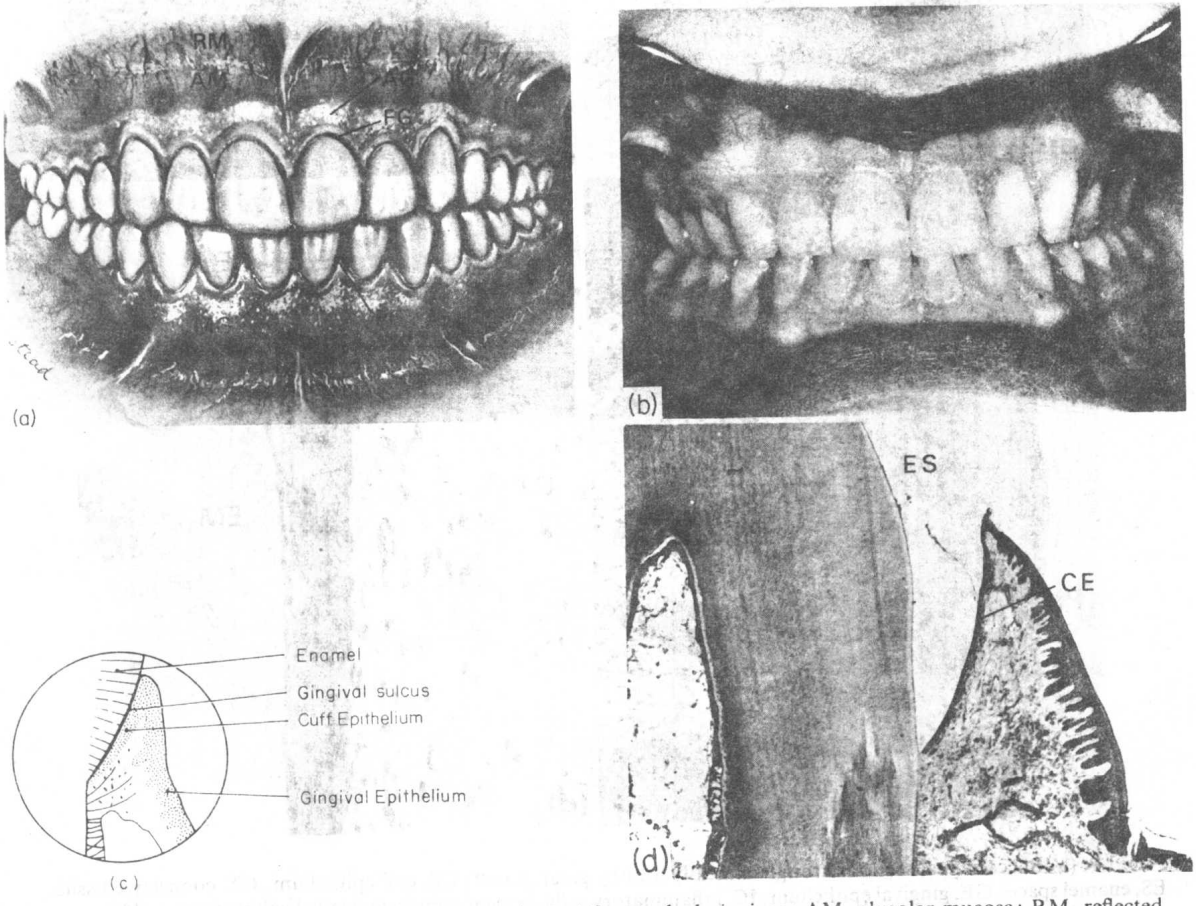

FIG. 1.8. The normal mouth. (a) FG, free gingivae; AG, attached gingivae; AM, alveolar mucosa; RM, reflected mucosa; PG, papillary gingivae; MG, marginal gingivae; drawing by courtesy of Dr A.R. McGregor. (b) Clinical photograph of a normal mouth. (c) Diagram of the gingival cuff. (d) Photomicrograph of a gingival cuff; ES, enamel space; CE, cuff epithelium.

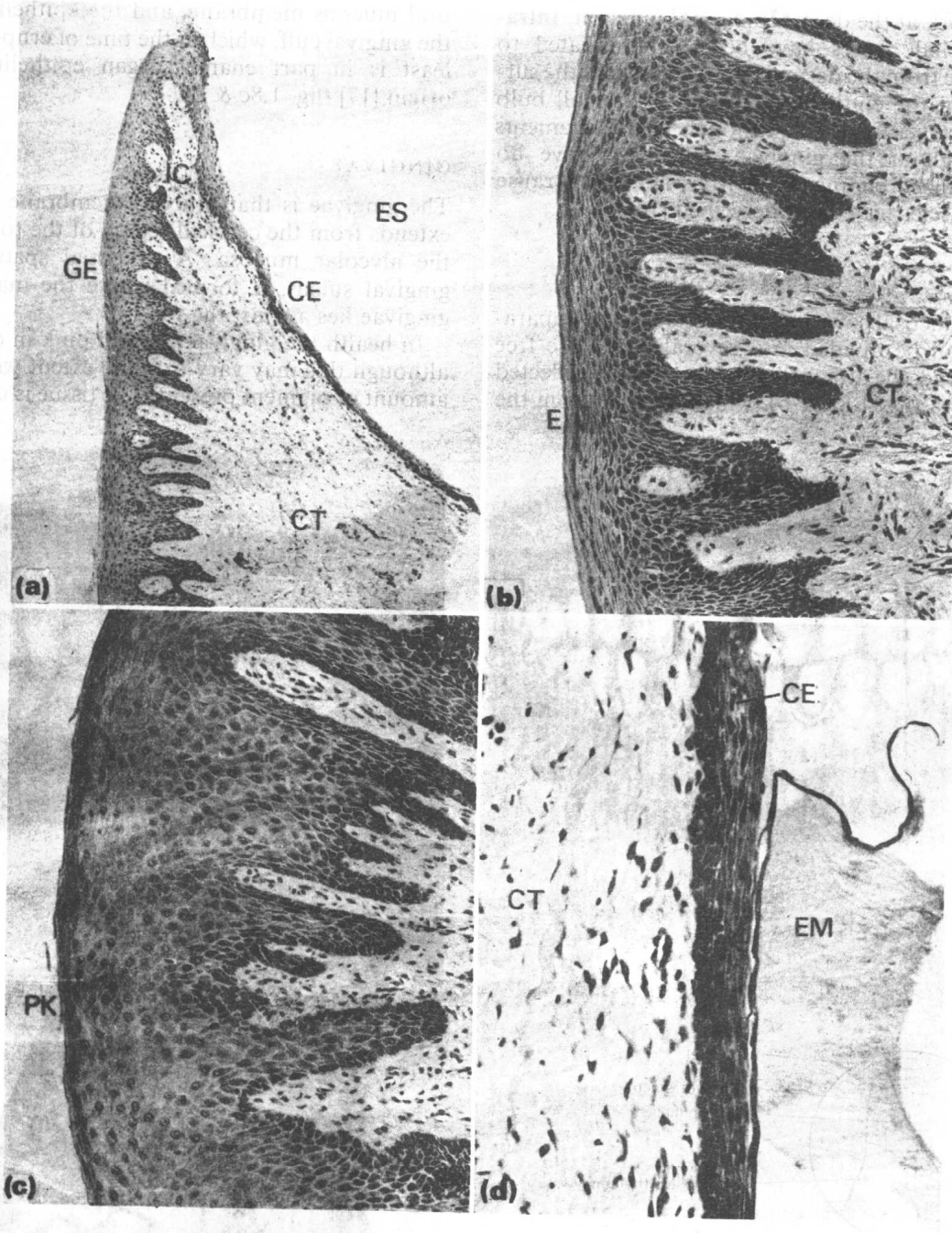

FIG. 1.9. (a) Buccolingual section through clinically healthy gingival cuff; CE, cuff epithelium; CT, connective tissue; ES, enamel space; GE, gingival epithelium; IC, inflammatory cells, present even in clinically healthy gingiva. (b) Section of gingival epithelium with underlying connective tissue (CT); epithelium (E) shows keratinization (orthokeratinization). (c) Section of gingival epithelium showing parakeratinization (PK), i.e. presence of nuclei in keratinized layer. (d) High power of healthy cuff epithelium (CE) which is non-keratinized. Note the close relationship to the enamel matrix (EM) and the absence of inflammatory cells in the connective tissue (CT).

firm in consistency, and closely adapted to the tooth at the cervical margin (fig. 1.8a & b). Histologically, the gingivae consist of a corium of connective tissue covered by stratified squamous epithelium (fig. 1.9a). On the labial and lingual aspects the gingival epithelium is usually keratinized (fig. 1.9b) or parakeratinized (fig. 1.9c), whilst the cuff epithelium is nonkeratinized (fig. 1.9d). The gingival tissues are held in close contact with the teeth by collagen bundles, which run from the papillary layer of the dermis to cementum and alveolar bone. Interposed between these fibre bundles are the cells, vessels, nerves, and ground substances of the connective tissue. Even in clinically healthy tissues a few mononuclear inflammatory cells can usually be observed in the gingival tissues (fig. 1.9a).

Free gingivae

The gingival tissue adjacent to the crown of the tooth is normally detached to a depth of 0·5 mm giving rise to the gingival sulcus and is termed the free gingivae. For descriptive purposes this is sub-divided into the marginal gingivae, situated labially and lingually, and the papillary gingivae, which is interdental in position (fig. 1.8a & b).

Attached gingivae

The attached gingivae extends from the apical margin of the free gingivae, which is a line called the gingival groove, to the line of reflection of the oral mucosa from the alveolar process to the lips and cheeks. It has a stippled appearance due to well-developed collagen bundles that course at right angles to the bone, binding the mucosa down as firmly united mucoperiosteum (fig. 1.8a & b).

ALVEOLAR MUCOSA

The alveolar mucosa (fig. 1.8a & b) is loosely attached to the underlying periosteum in the region of the line of reflection and is increasingly separated from the underlying bone by a loose connective tissue stroma. Histologically, there is a gradual change from attached gingivae to alveolar mucosa (fig. 1.10). The most prominent change occurs at the epithelium connective tissue junction where the epithelial ridges become progressively shorter. The epithelium is nonkeratinized and an increase in the proportion of elastic fibres occurs in the underlying connective tissue.

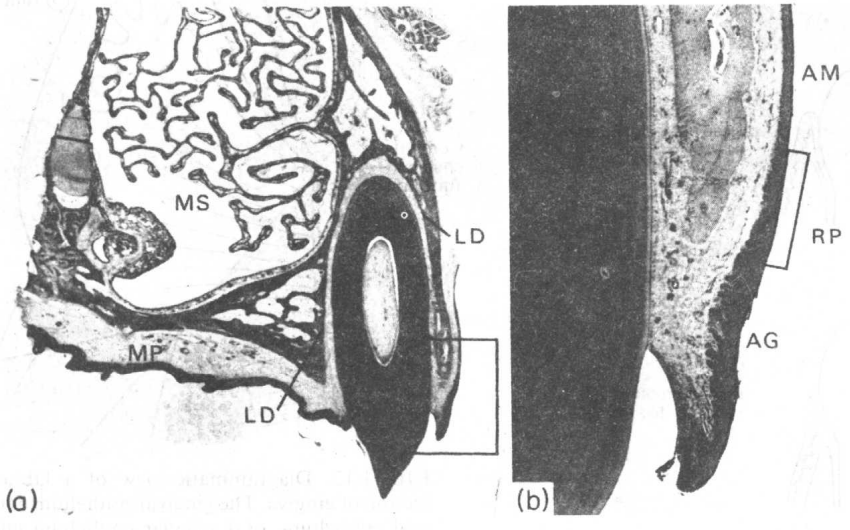

FIG. 1.10. Buccopalatal section of canine of cat, (a) Maxillary air sinus (MS), mucous membrane of palate (MP), lamina dura of socket (LD). (b) Higher power of area indicated in fig. 1.10a. A progressive shortening of the epithelial ridges (rete pegs, RP) occurs with the transition of tissue from attached gingiva (AG) to alveolar mucosa (AM).