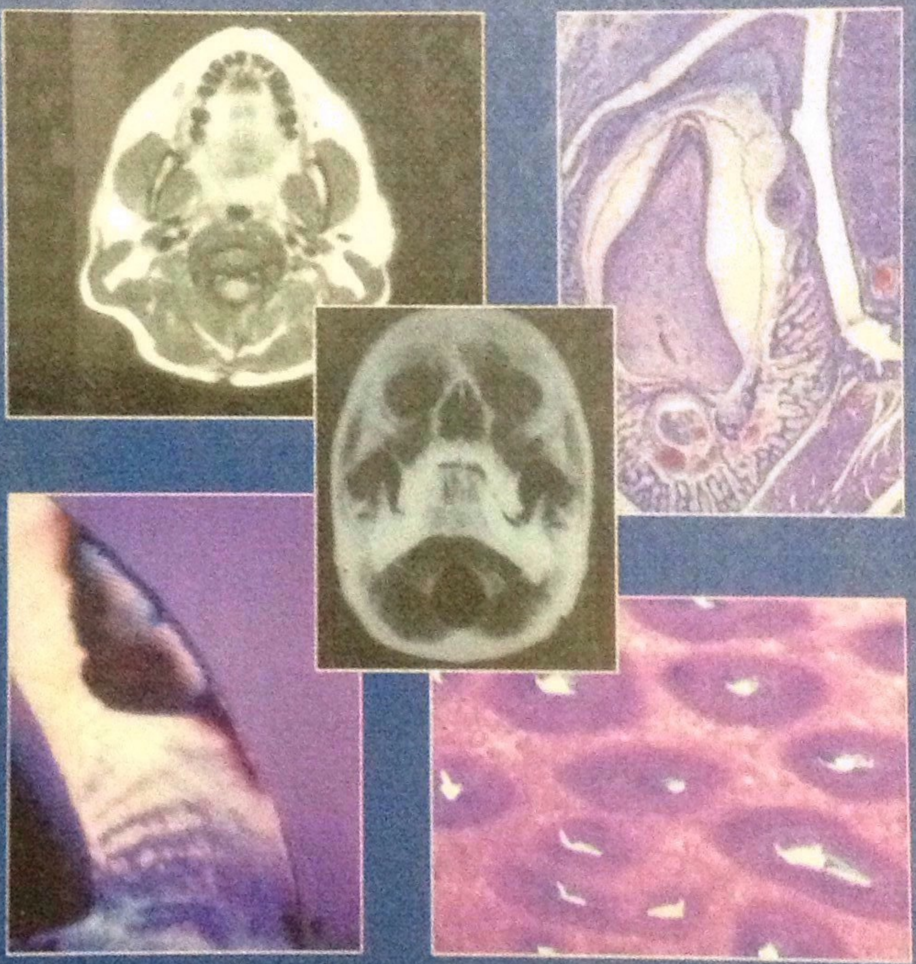
SELF-ASSESSMENT PICTURE TESTS IN

DENTISTRY

Oral Anatomy, Histology and Embryology



Barry K B Berkovitz
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Mosby-Wolfe

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Oral Anatomy, Histology and Embryology

Dr. Al. Bayaty
Trinidad
2004

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Preface

The scientific subjects within dentistry are undergoing major educational revisions in almost every dental school in the world. We remain convinced however that, without a full understanding of oral anatomy, histology and embryology, the dental undergraduate will remain ill-equipped for his/her clinical studies. In producing this book, we were particularly conscious of four major considerations:

Firstly, in these days of 'student-centred learning' it is becoming increasing important that students should assess their progress by frequent testing of their knowledge and skills. This book has been written, not specifically for the purpose of examinations, but to help dental students at various stages of their courses to revise. This distinction is of some importance since it allows some items to be included on controversial matters which might not be considered suitable for examinations.

Secondly, a proper appreciation of oral anatomy does not rely upon the assimilation of a mass of facts because the subject is essentially 'visual' and cannot be mastered simply by reading a text. In addition to some true/false questions to test factual knowledge we have therefore provided the opportunity for the student to assess his/her development of a visual appreciation of the material comprising oral anatomy by incorporating numerous questions based upon micrographs and illustrations (both in colour and black and white).

Thirdly, although oral anatomy in many dental schools remains a 'preclinical' subject, it is best appreciated when its relevance to the clinic is highlighted. We have therefore included case histories that require some anatomical information for their education. We hope that these will not only confirm the importance of basic oral anatomy to the clinical situation but will encourage a problem solving approach to learning and will aid motivation.

Fourthly, as examiners at many dental schools we are only too aware of the pressures nowadays placed upon the dental curriculum. Whilst it is undoubtedly tempting to cut material from courses, it is exceedingly difficult to do this without a resulting significant drop in standards. This book was written with the clear aim of presenting a body of material that we believe approximates to the minimum standards required for undergraduate dental students undertaking courses which include topics belonging to oral anatomy, histology and embryology.

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Wenner-Gren Foundation *(Figure 162)*;
D.K. Whittaker *(Figure 62)*, University of Wales.

Contents

The Mouth

1 Which of the following statements are true:

(a) The oral cavity is demarcated from the oropharynx by the palatoglossal folds.

(b) When the teeth are in occlusion, the vestibule of the mouth communicates with the oral cavity proper in the retromolar region.

(c) The linea alba in the cheek is a hyperkeratinised line representing the site of the occlusal plane.

(d) The parotid gland usually drains opposite the maxillary second molar tooth.

(e) The soft palate during swallowing is depressed to meet Passavant's ridge on the posterior wall of the pharynx.

(f) The openings of the submandibular glands lie in the most lateral parts of the sublingual folds.

(g) Waldeyer's ring consists solely of the lymphatic tissue of the palatine tonsils and the lingual tonsils.

(h) The lingual frenum usually crosses the floor of the mouth to terminate immediately behind the lower incisors.

(i) The sulcus terminalis divides the tongue into a smaller anterior part and a larger posterior part.

(j) The foramen caecum on the tongue represents the site of development of the thymus gland.

2 The picture shown *(Figure 1)* is of the hard palate in the roof of the mouth.

(a) Identify the features labelled A to D.

(b) What type of mucosa covers this region?

(c) Where precisely would you locate the major nerves supplying the hard palate?

(d) Why is it difficult for infections (pus) arising from a maxillary tooth to spread along the hard palate?

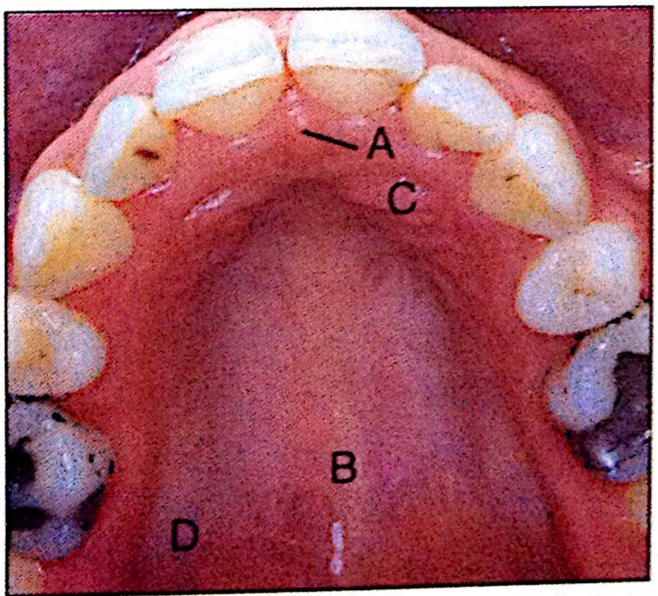


Figure 1

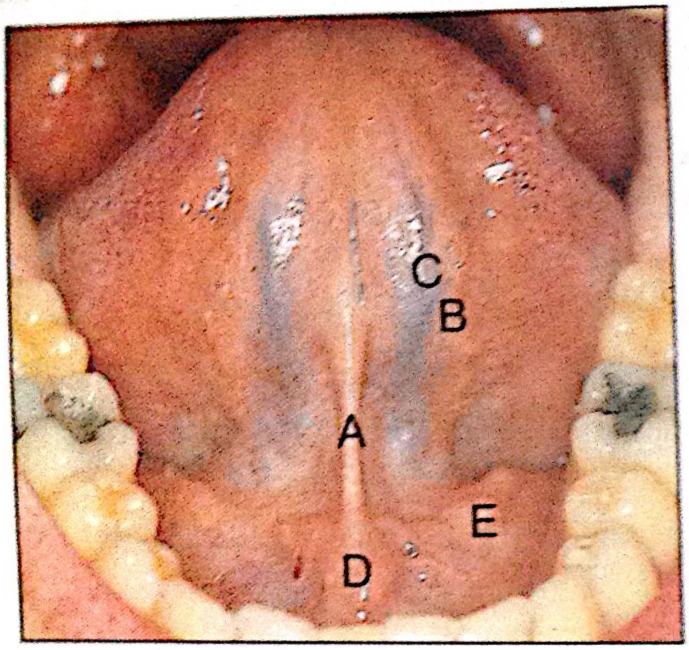


Figure 2

3 Pictured is the ventral surface of the tongue *(Figure 2)*.

(a) Identify the features labelled A to E.

(b) With what anatomical structures are the features labelled D and E associated?

(c) What type of mucosa covers this region?

(d) How can infections from a mandibular tooth 'pointing' beneath the tongue spread into the submandibular region of the neck?

Figure 3

4 An 18-year-old youth, on cleaning her teeth, noticed for the first time that there were numerous small, light-yellow spots in the mucosa of her cheeks *(Figure 3)*. Close inspection by her dentist revealed occasional ducts from which was exuding a greasy substance. A biopsy was taken and the histology of the region is shown in *Figure 4*.

(a) What are these structures?

(b) Why are they present in the cheek region?

(c) Why did they appear at this time?

Figure 4

The Jaws

5 Which of the following statements are true:

(a) The jaws are part of the viscerocranium which houses and protects the cranial parts of the respiratory and digestive tracts.

(b) Each maxillary bone consists of a body and zygomatic, frontal, alveolar and palatine processes.

(c) The infra-orbital foramen in the maxilla transmits the infra-orbital branch of the ophthalmic nerve.

(d) The greater and lesser palatine foramina are wholly located in the palatine processes of the maxillary bones.

(e) The ramus of the mandible shows an angle inferiorly, a condylar process supero-anteriorly, and a coronoid process supero-posteriorly.

(f) The mental foramen usually lies in the body of the mandible, below the mesial root of the first permanent molar tooth.

(g) The genial (mental) tubercles (spines) provide attachments for the digastric muscles.

(h) The maxillary air sinus is best visualised radiographically from a lateral skull radiograph.

(i) The most that can be assessed from standard radiography of the temporomandibular joint is the mode of functioning of the condyle within the glenoid (mandibular) fossa.

(j) The lamina dura is a radio-opaque line representing the hypermineralised cortical bone lining the tooth socket.

6 *(Figure 5)*

(a) Identify the structures (A to H) labelled on this picture which illustrate the osteology of the hard palate.

(b) How on a lateral skull radiograph (taken using a cephalostat) would you draw a plane to indicate the line of the maxilla?

(c) What is the precise origin of the nerves entering/leaving the foramina labelled D, F and G?

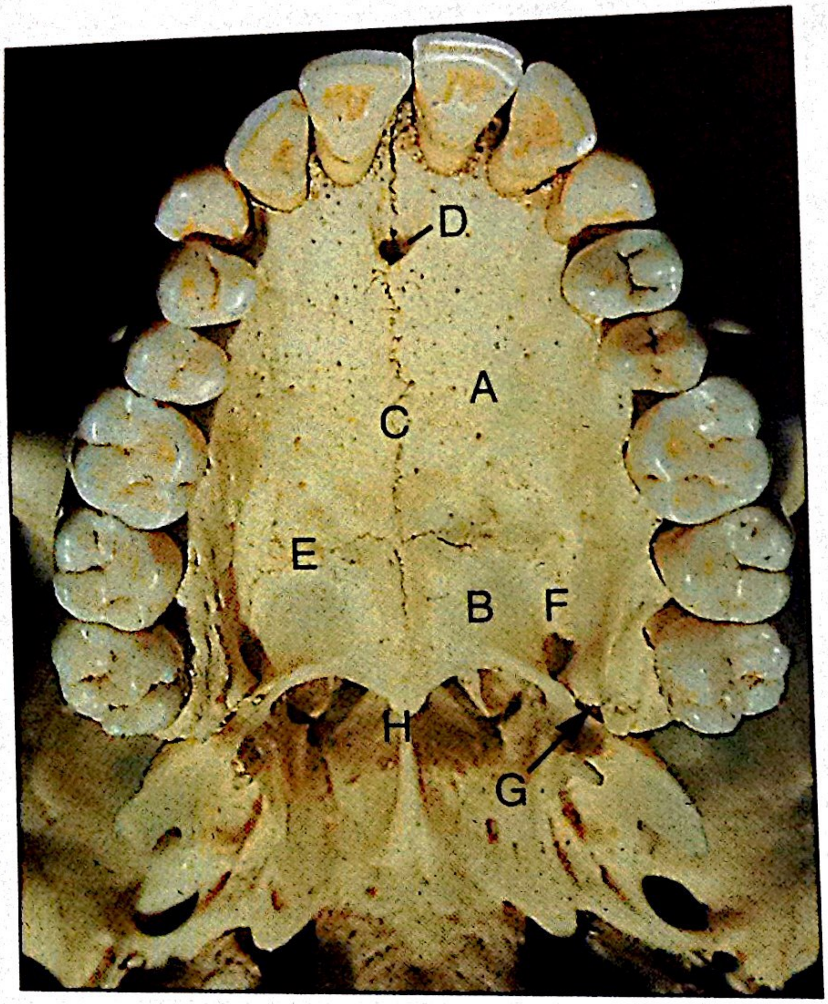


Figure 5

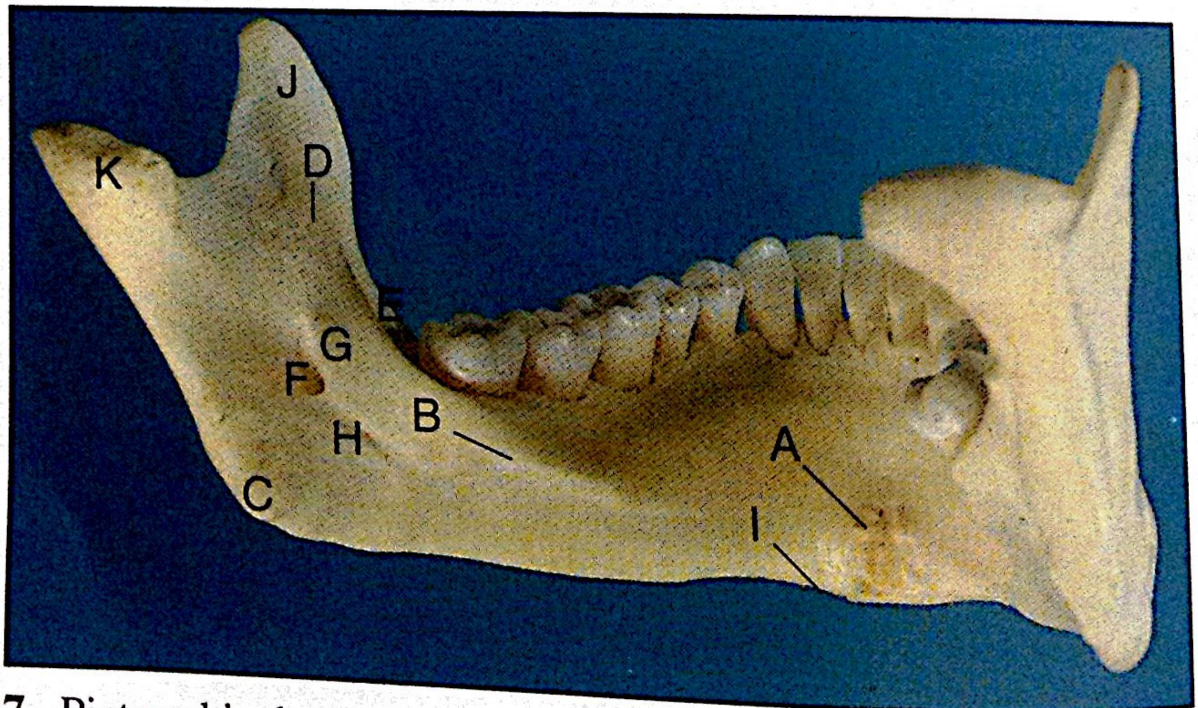


Figure 6

7 Pictured is the inner (medial) surface of the mandible *(Figure 6)*.

(a) Identify the features labelled A to K.

(b) What is attached to G and what is its embryological origin?

(c) Which muscles gain attachment to A, B, C, D, and I?

(d) What structure running close to E is endangered when the mandibular third molar tooth is surgically removed?

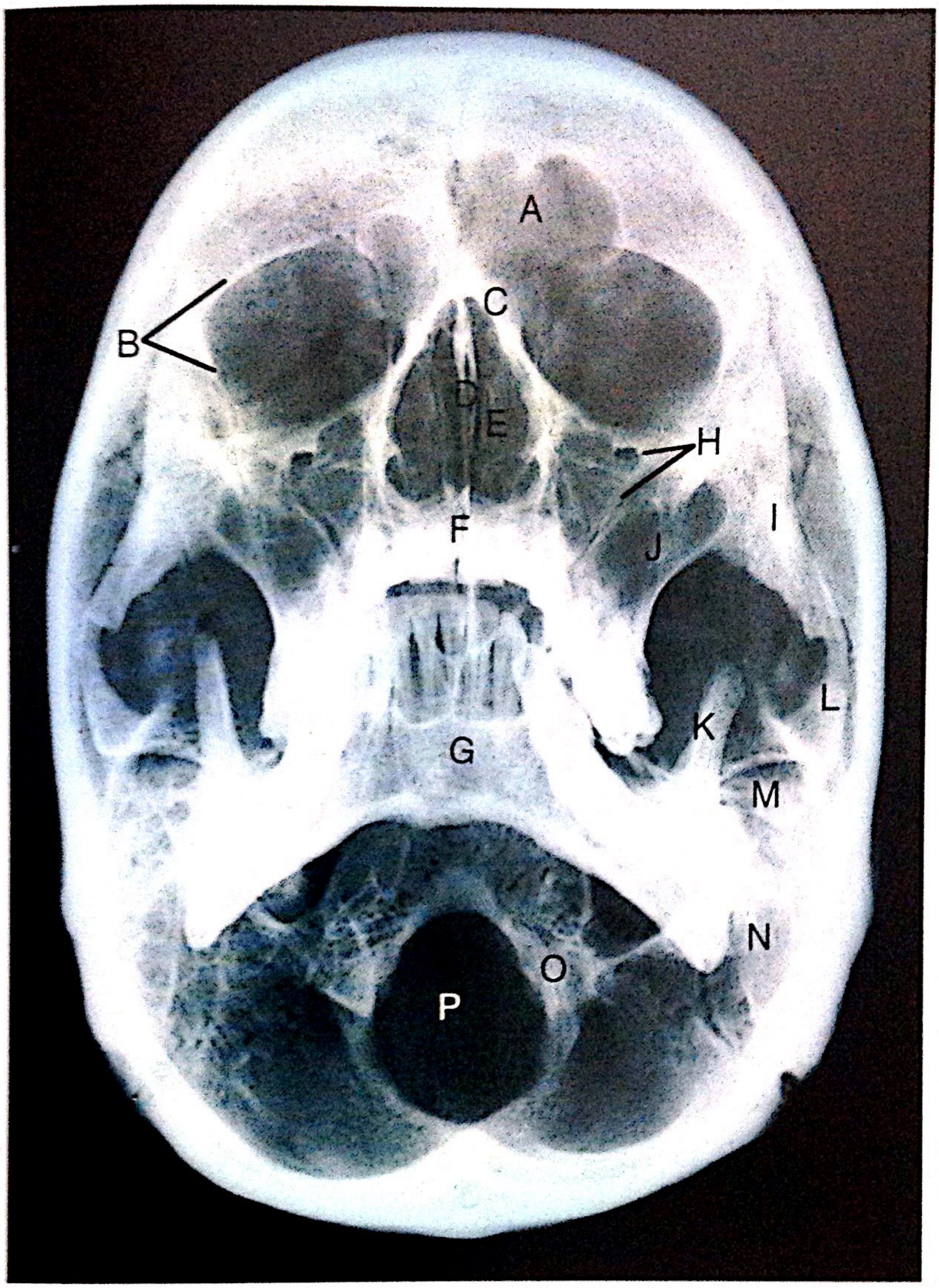


Figure 7

8 *(Figure 7)*

(a) What is the projection used for radiographing this skull?

(b) Identify the structures labelled A to P.

(c) What is the clinical significance of taking this type of radiograph?

(d) What features indicate that this is a radiograph of an anatomical specimen and not of a living patient?

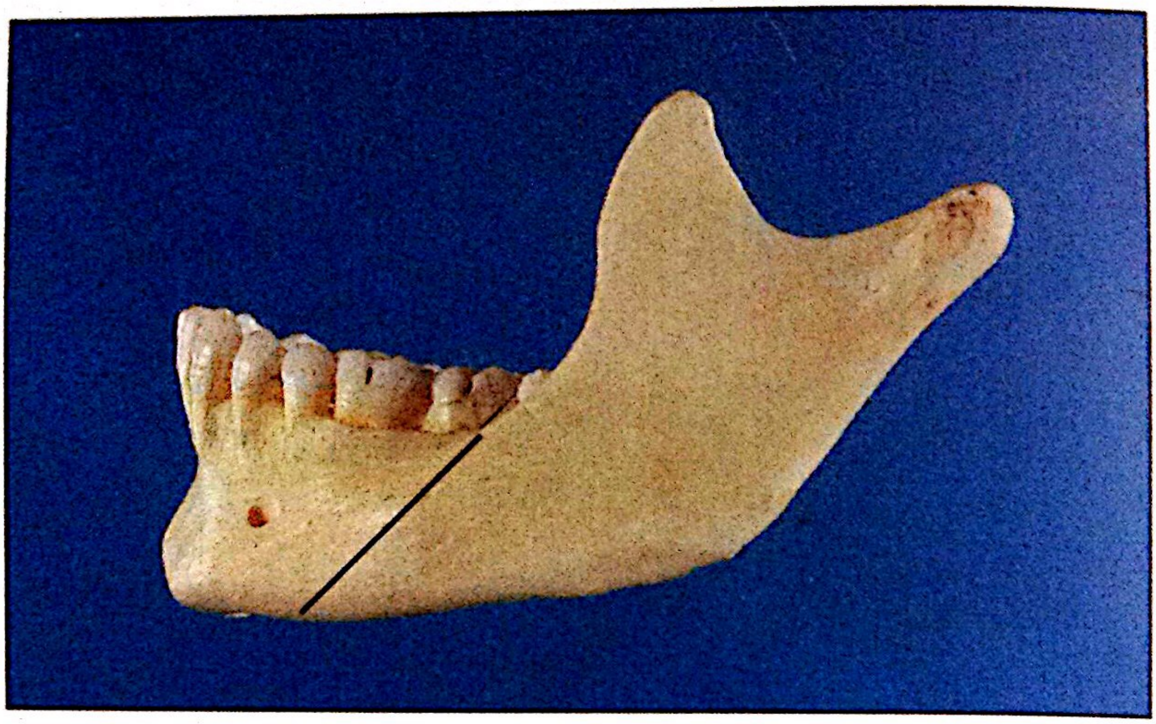


Figure 8

9 *(Figure 8)*

(a) The line drawn on the mandible illustrated represents a fracture line. Bearing in mind the directions of pull of the muscles on either side of the line, is the fracture favourable (ie the fragments remain together) or unfavourable?

(b) Fracture of the mandibular condyle is not uncommon. Assuming that the condyle is driven inwards, which blood vessels may be disrupted to cause intracranial haemorrhage?

10 Pictured is the inner surface of the mandible adjacent to the floor of the mouth *(Figure 9)*.

(a) Are the arrowed structures normal anatomical structures?

(b) Where else in the mouth are similar structures found?

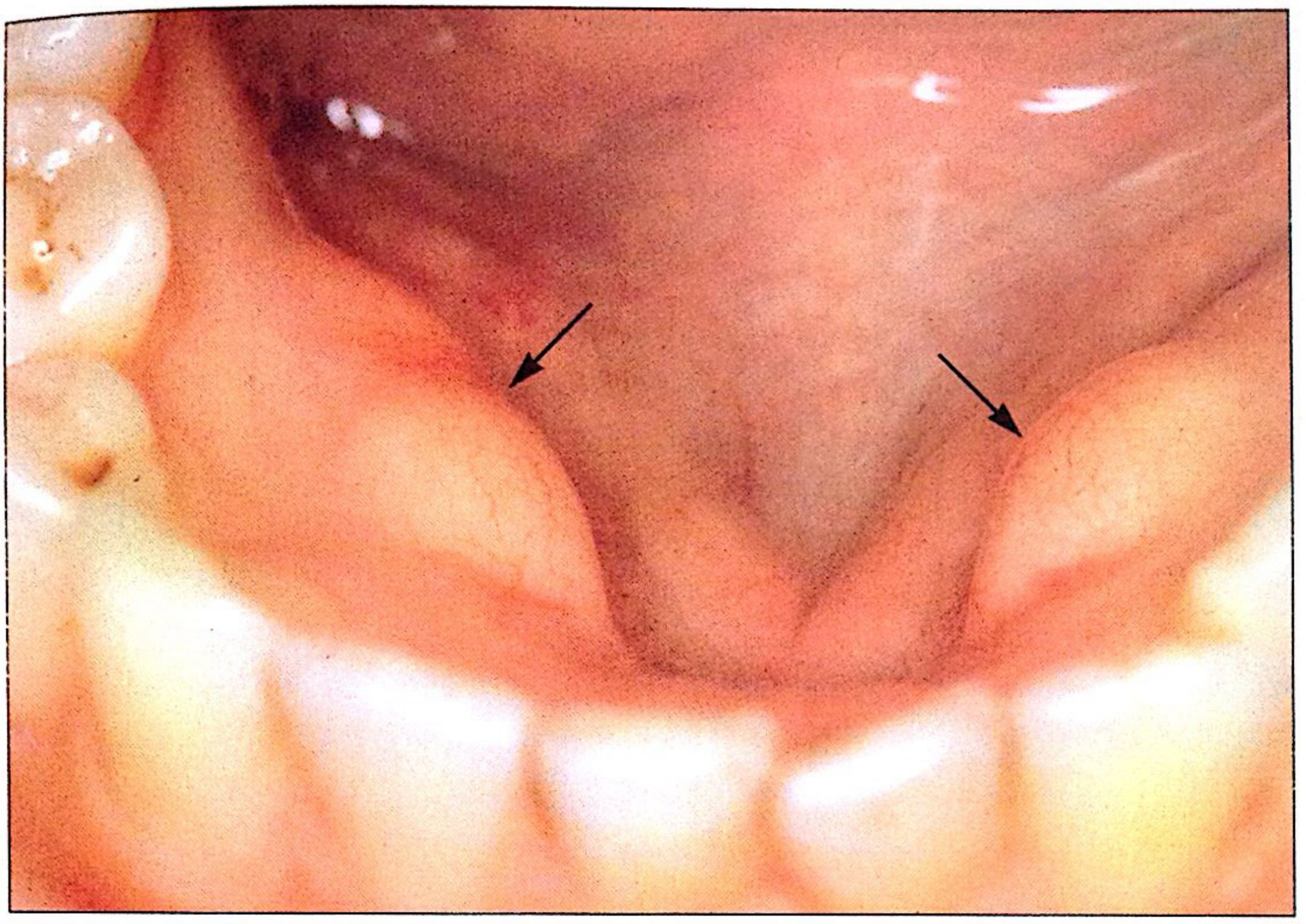


Figure 9

11 What is unusual about this dentition *(Figure 10)*, and with what normal anatomical structure is it associated?

Figure 10

12 Which of the following statements are true:

(a) The maxillary central permanent incisor frequently exhibits a pit in front of the palatal cingulum.

(b) The maxillary permanent canine presents a marked convexity at the junction of the mesial surface and incisal edge.

(c) The mandibular first premolar has two pulp horns, one for each cusp, extending from the roof of the pulp chamber.

(d) The tip of the palatal cusp of the maxillary second premolar is generally displaced towards the distal surface of the crown.

(e) The outline of the maxillary first permanent molar is rhombic, the mesiobuccal and distopalatal angles being obtuse.

(f) The distal root of the mandibular second permanent molar invariably contains two root canals.

(g) The maxillary third permanent molar is the tooth most likely to become impacted.

(h) Like their permanent successors, the roots of the mandibular deciduous incisors are compressed mesiodistally.

(i) The buccal surface of the crown of the mandibular first deciduous molar shows a conspicuous bulge above the distal root.

(j) A cusp of Carabelli is infrequently found in the maxillary second deciduous molar.

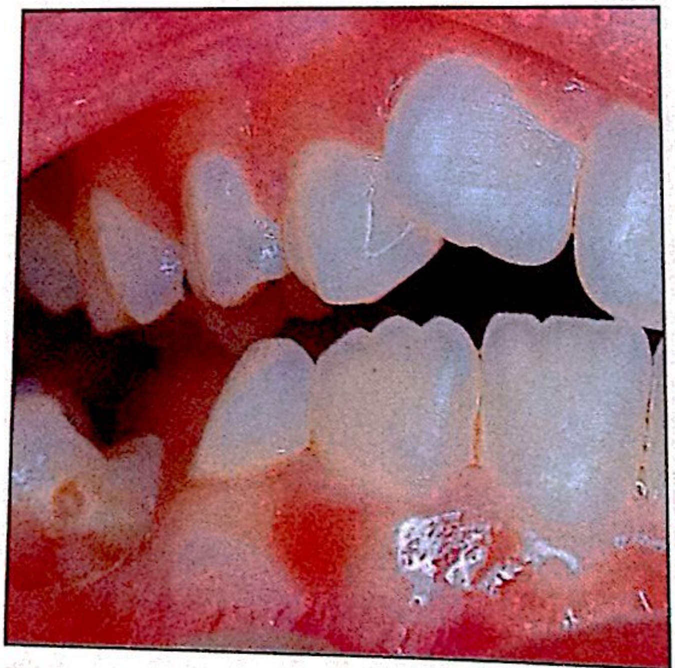


Figure 11

13 Is there anything unusual about the incisal margins of the mandibular permanent incisors? *(Figure 11)*

14 Is there anything unusual about this mandibular permanent canine? *(Figure 12)*

Figure 12

15 How do you account for the appearance of the roots of this tooth? *(Figure 13)*

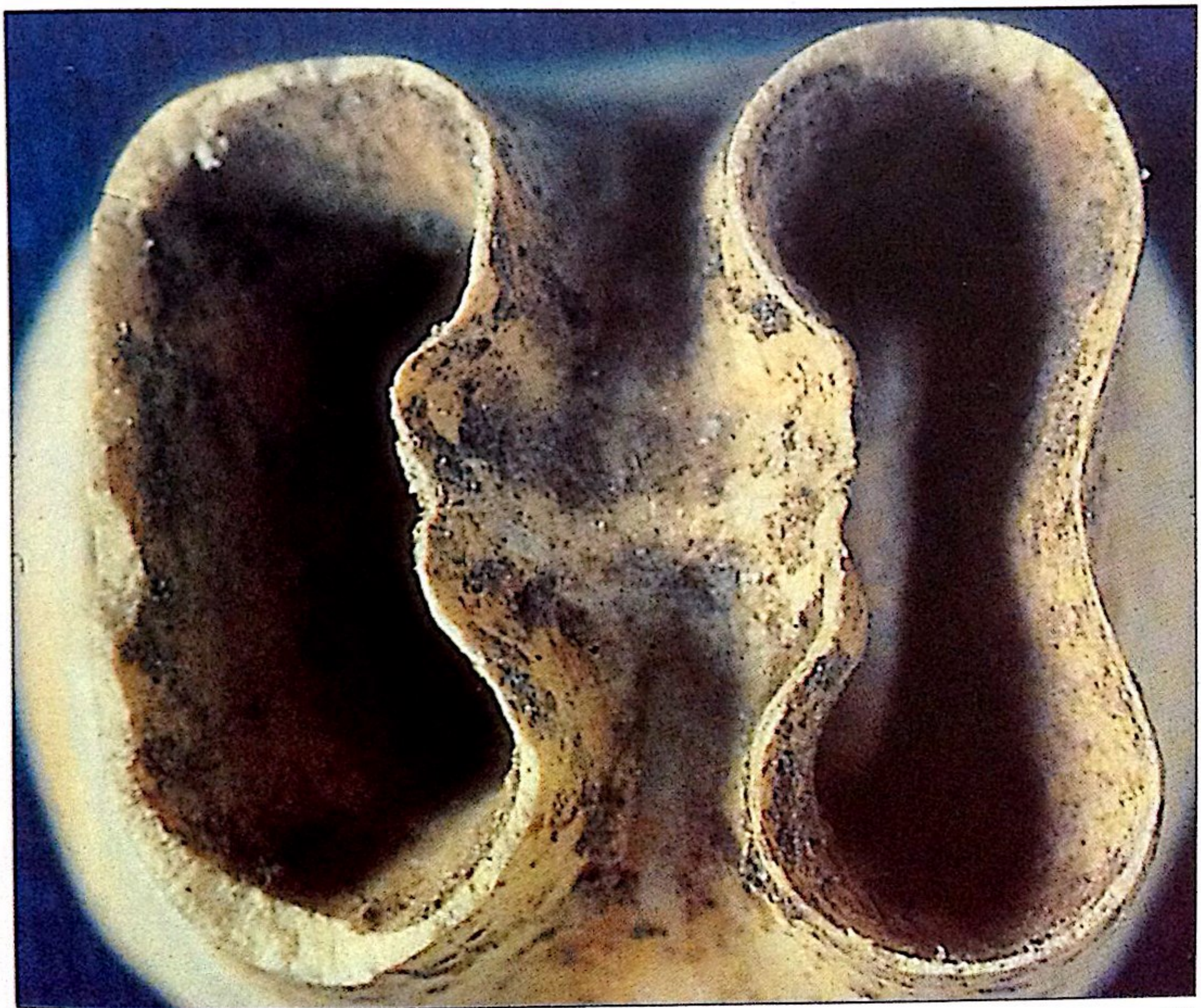


Figure 13

16 – 24 For each illustration (*Figures 14 – 22*):
(a) Identify the tooth, indicating the surface viewed.
(b) Give the date when the crown of each tooth commences calcification.
(c) Give the date each tooth erupts into the oral cavity.
(d) For questions 16, 19, 20 and 21, list the nerves which must be anaesthetised in order to extract the tooth.

16

Figure 14

17

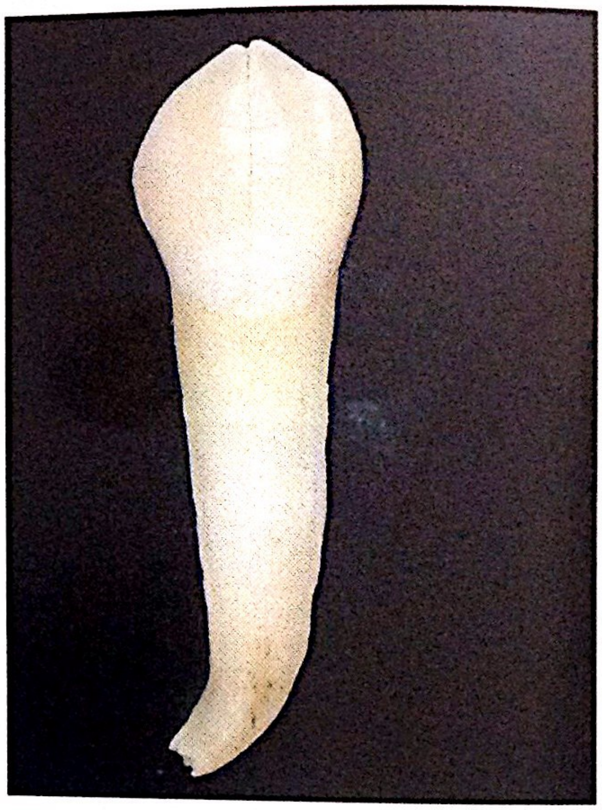


Figure 15

18

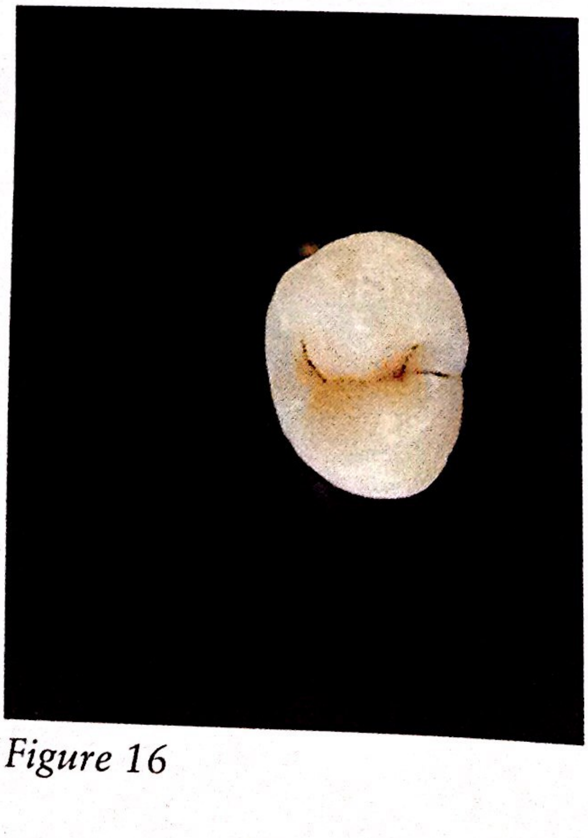


Figure 16

19

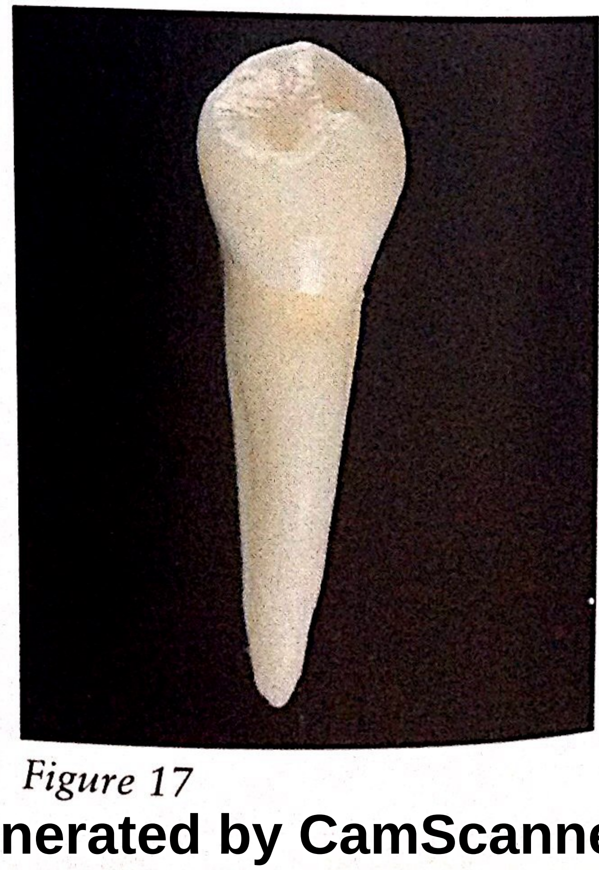


Figure 17

20

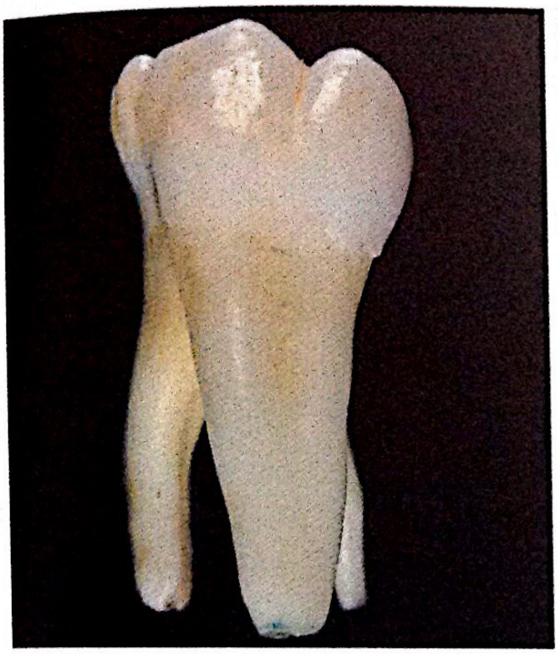


Figure 18

21

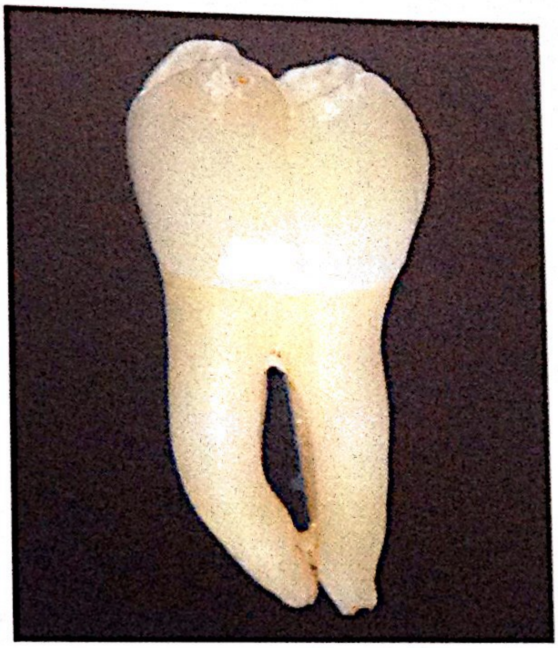


Figure 19

22

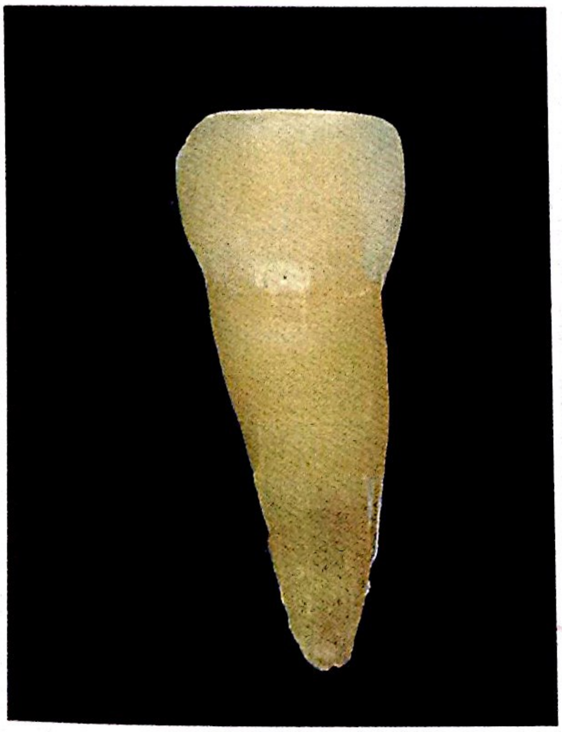


Figure 20

23

Figure 21

24

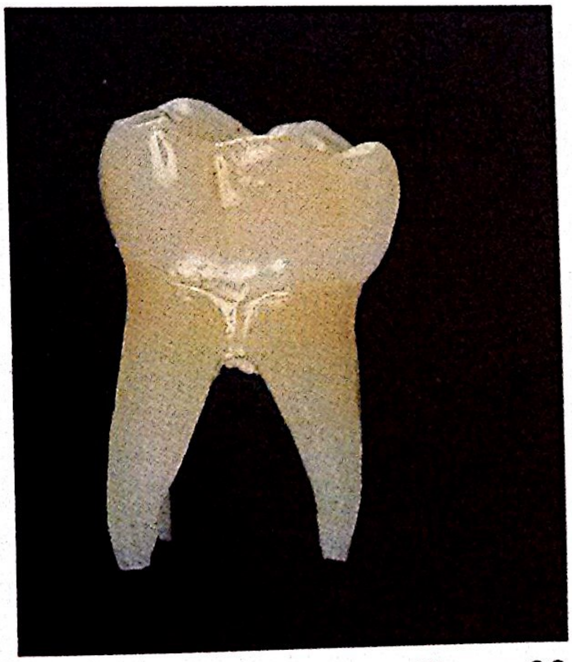


Figure 22

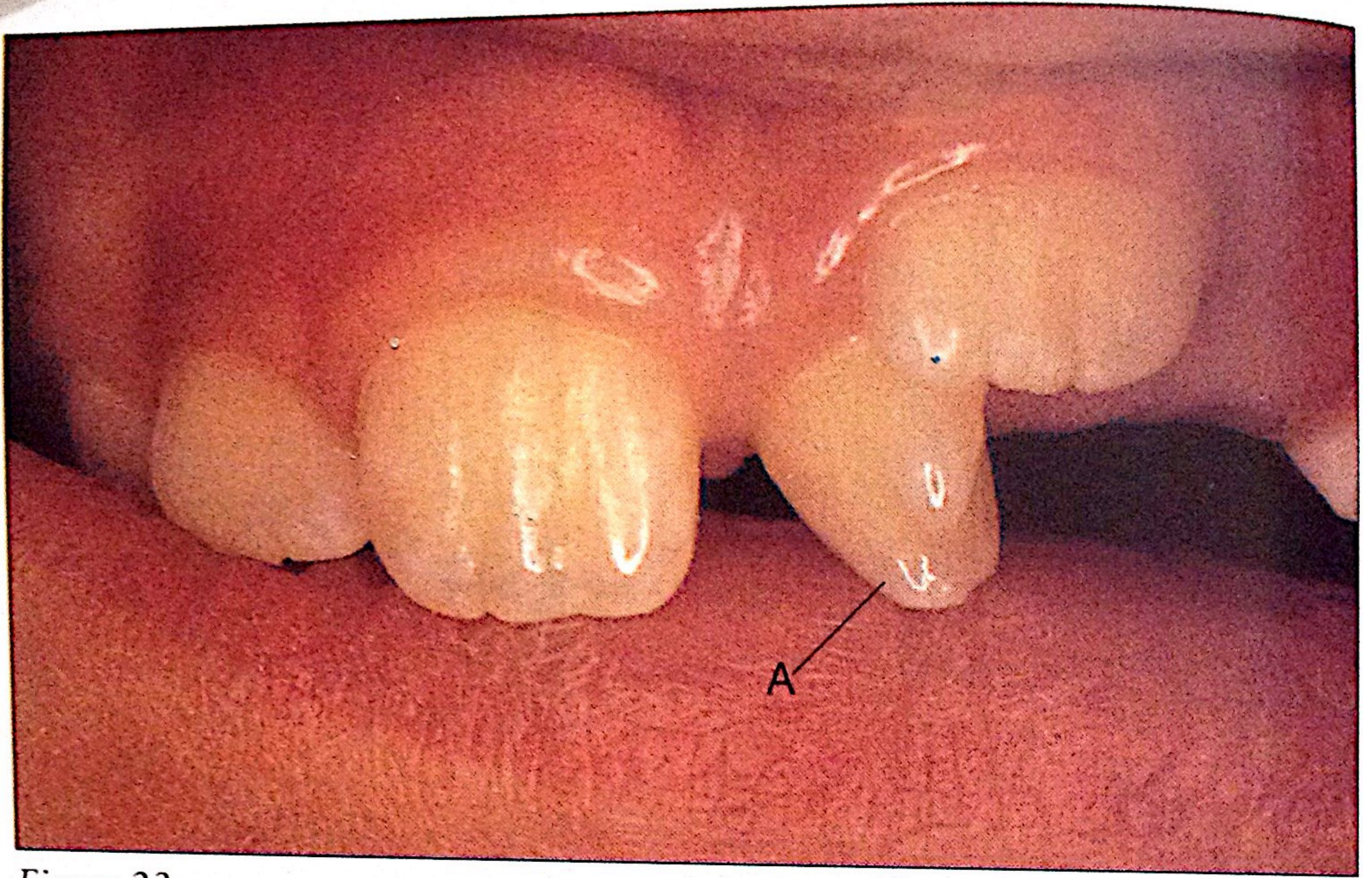


Figure 23

25 Identify structure A *(Figure 23)*. How else may it present clinically?

26 Is anything abnormal in this radiograph of the dentition? *(Figure 24)*

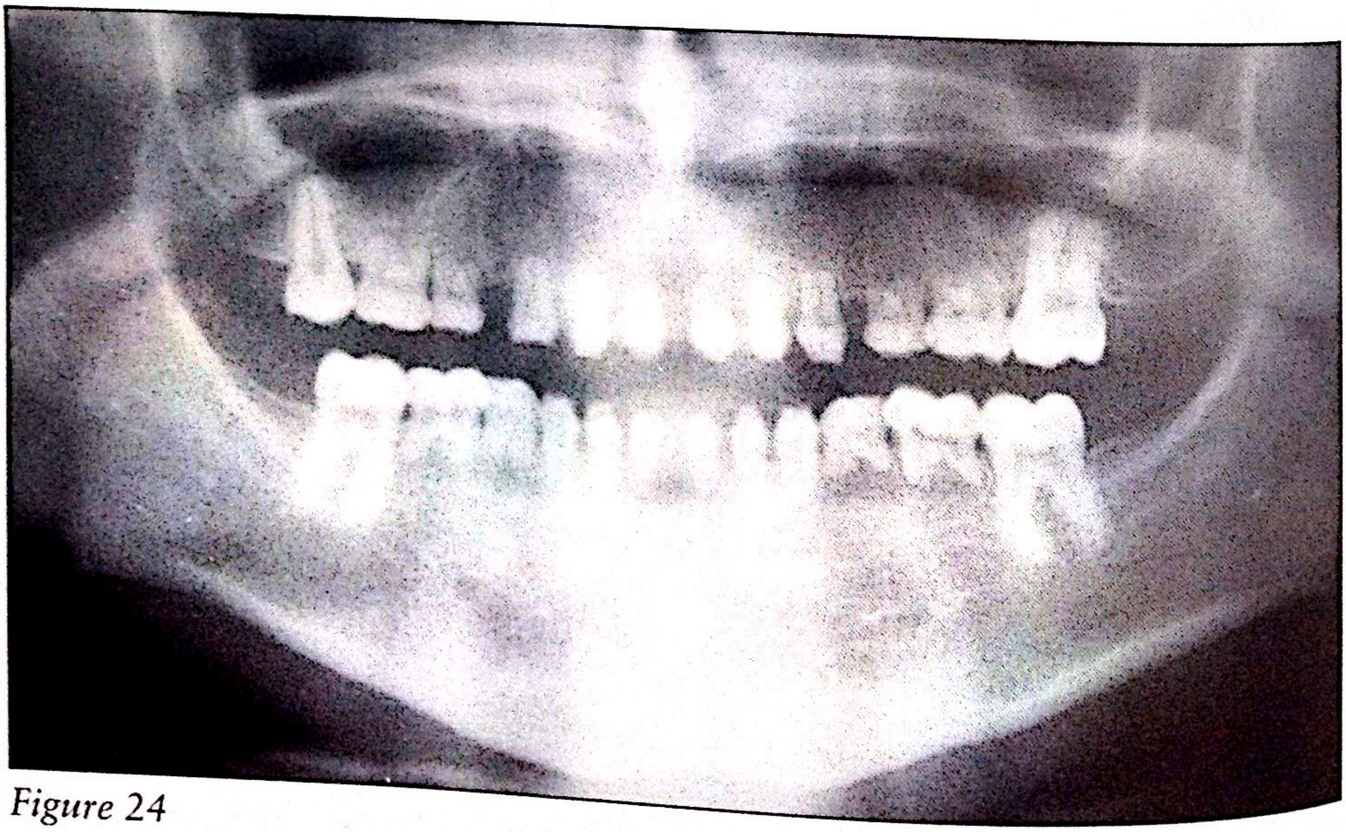


Figure 24

Occlusion

27 Which of the following statements are true:
(a) Viewed occlusally, the dental arches are generally rectangular in form.
(b) The curvature of the dental arches seen laterally (ie in the sagittal plane) is termed the curve of Monson.
(c) Normal (anatomical) occlusion represents the occlusion most prevalent in the community.
(d) When the teeth are in centric occlusion, the mandibular condyles are centrally positioned in the glenoid (mandibular) fossae of the temporal bones.
(e) All mandibular molars bear a distal relationship to the maxillary molars.
(f) Excluding the permanent third molars, the most commonly malaligned tooth is the permanent maxillary canine.
(g) The subspinale is the innermost part of the curve from the anterior nasal spine to the maxillary alveolus.
(h) The Frankfort plane extends from the Portion to the Nasion.
(i) The 'normal' angle between the Frankfort plane and the long axis of the maxillary incisors is 90%.
(j) A negative difference between SNA and SNB angles is indicative of a skeletal Class II relationship of the jaws.

28 *(Figure 25)*
(a) Identify the landmarks A to M shown on the tracing provided from a lateral skull cephalometric radiograph.
(b) Provide two basic clinical reasons for taking a cephalometric radiograph for a dental patient.
(c) Which landmarks are used to delineate planes describing the cranial base?

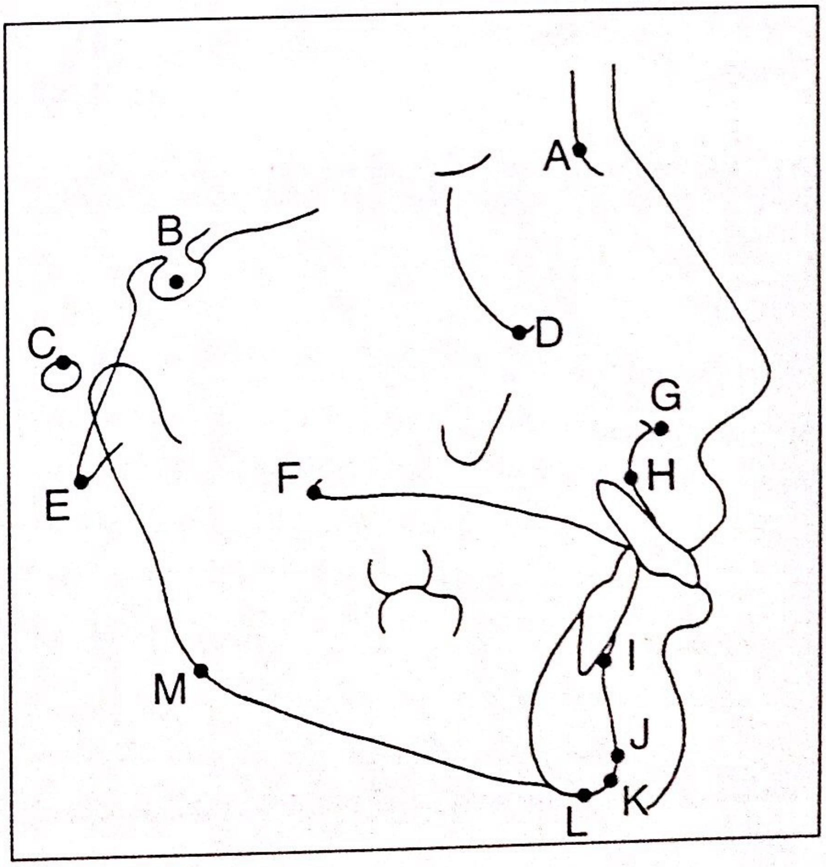


Figure 25

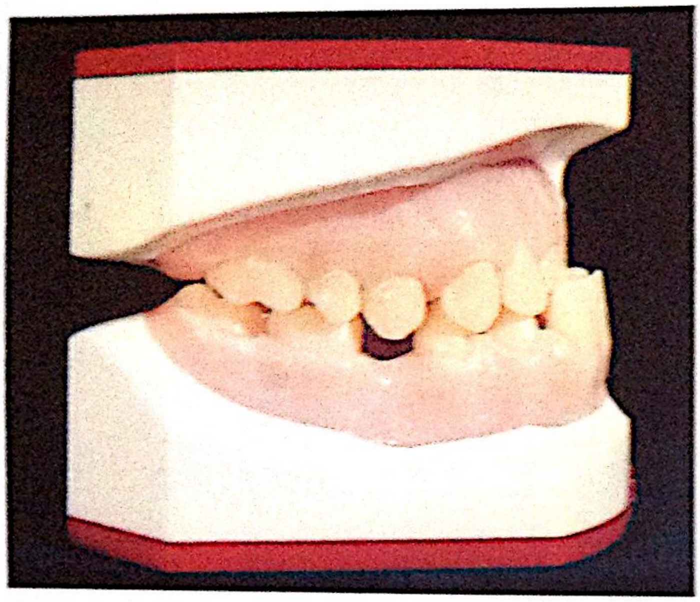


Figure 26

29 Using Angle's classification of occlusion, identify the occlusion illustrated here. *(Figure 26)*

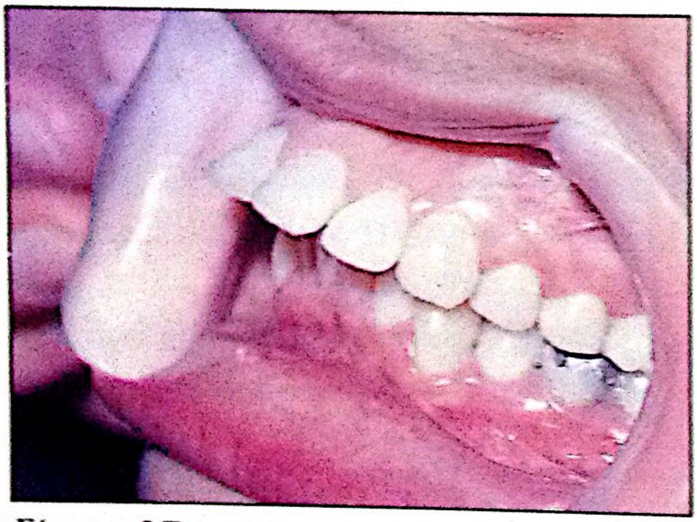


Figure 27

30 *(Figure 27)*

(a) Using the incisor classification of occlusion, identify the malocclusion shown here.

(b) Why is the incisor classification now preferred in the clinic to Angle's classification?

31 What type of malocclusion(s) is evident in this patient? *(Figure 28)*

Figure 28

32 What obvious malocclusion is evident in this patient (*Figure 29*) and with what is it often associated?

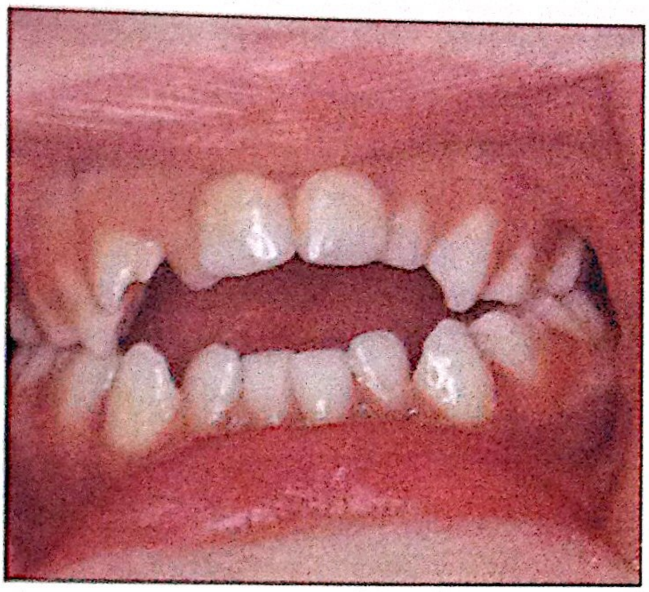


Figure 29

Floor of Mouth and Tongue

33 Which of the following statements are true:

(a) The mylohyoid muscle, forming the diaphragm for the floor of the mouth, is attached onto the external oblique line of the mandible.

(b) The following structures lie superficial to the hyoglossus muscle in the floor of the mouth: the deep part of the submandibular gland, the glossopharyngeal nerve, the hypoglossal nerve.

(c) The mucosa lining the floor of the mouth and the ventral surface of the tongue is innervated by the lingual branch of the mandibular nerve.

(d) The lymphatic drainage of structures in the floor of the mouth is to a sublingual group of lymph nodes.

(e) The submandibular parasympathetic ganglion receives preganglionic fibres from the glossopharyngeal nerve.

(f) The dorsum of the tongue is characterised by an abundance of papillae, the largest being the circumvallate papillae.

(g) The extrinsic muscles of the tongue alter its shape.

(h) All the tongue muscles, except palatoglossus, receive their motor innervation from the hypoglossal nerve.

(i) The lingual artery, a branch of the external carotid, reaches the tongue by passing across the superficial surface of the hyoglossus muscle.

(j) The sublingual salivary gland drains by a single duct into the sublingual papilla in the floor of the mouth.

34 Pictured is a median sagittal section through the head to show the tongue and the floor of the mouth *(Figure 30)*.

(a) Identify the structures labelled A to U.

(b) Which nerves innervate the muscles labelled N, O, P and Q?

(c) What is the function of the muscle labelled N?

(d) Which structures delineate the region labelled U and what is the clinical significance of this region?

(e) 'Swallowing of the tongue' (i.e. a backward displacement into the oropharynx) can occur during an epileptic seizure or during unconsciousness. Why does it not occur when the lingual nerves are anaesthetised on both sides of the mouth and what manipulations would you make to bring the tongue forward on an unconscious patient?

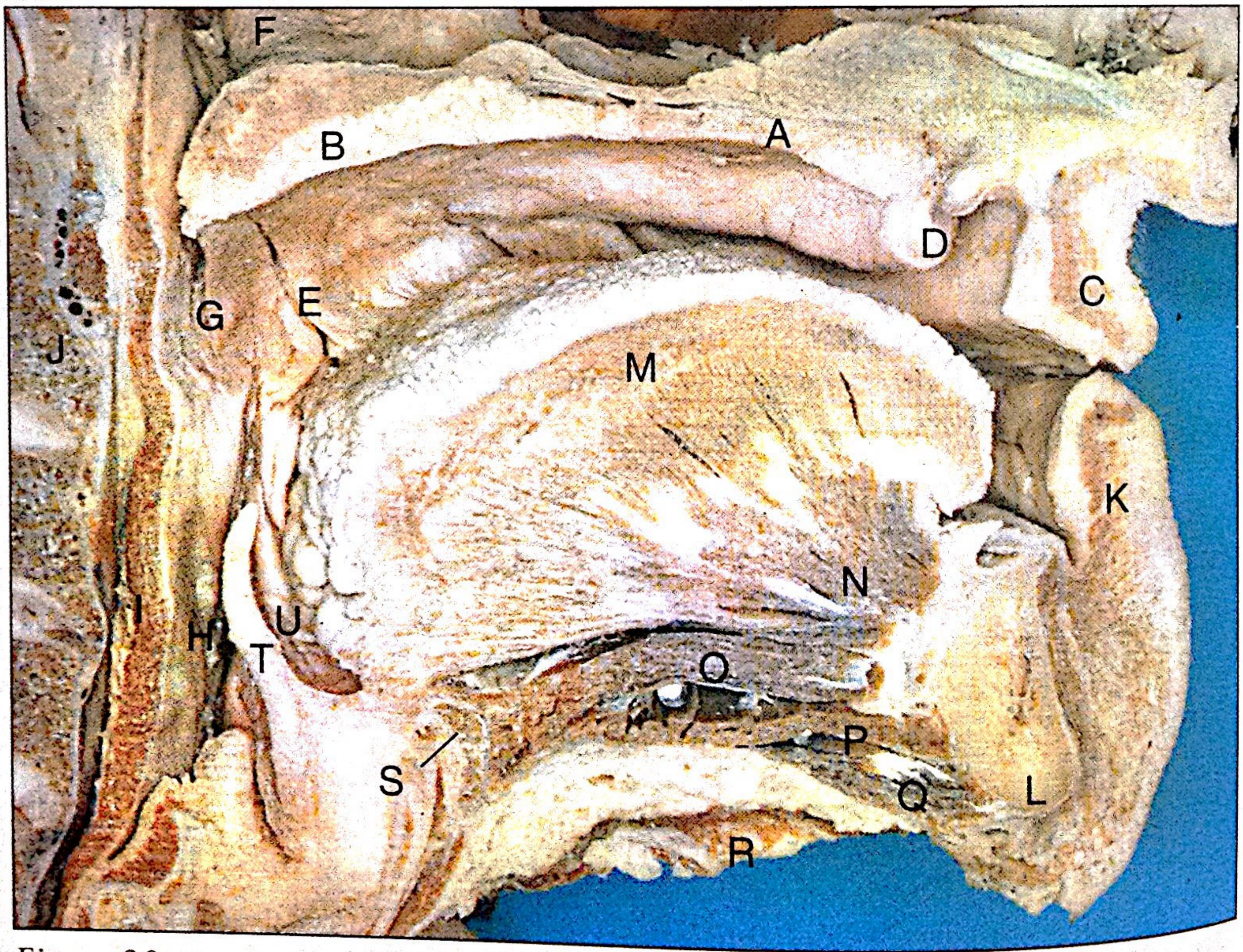


Figure 30

35 Pictured is a dissection of the deep submandibular region *(Figure 31)*.

(a) Identify the features labelled A to K.

(b) What would be the result of inadvertent section of the structure labelled J.

(c) State the specific types of secretion for the two salivary glands in this region.

(d) From knowledge of the anatomy of the region of the floor of the mouth, explain how a large retention cyst from the sublingual salivary gland (a ranula) can plunge down into the neck.

Figure 31

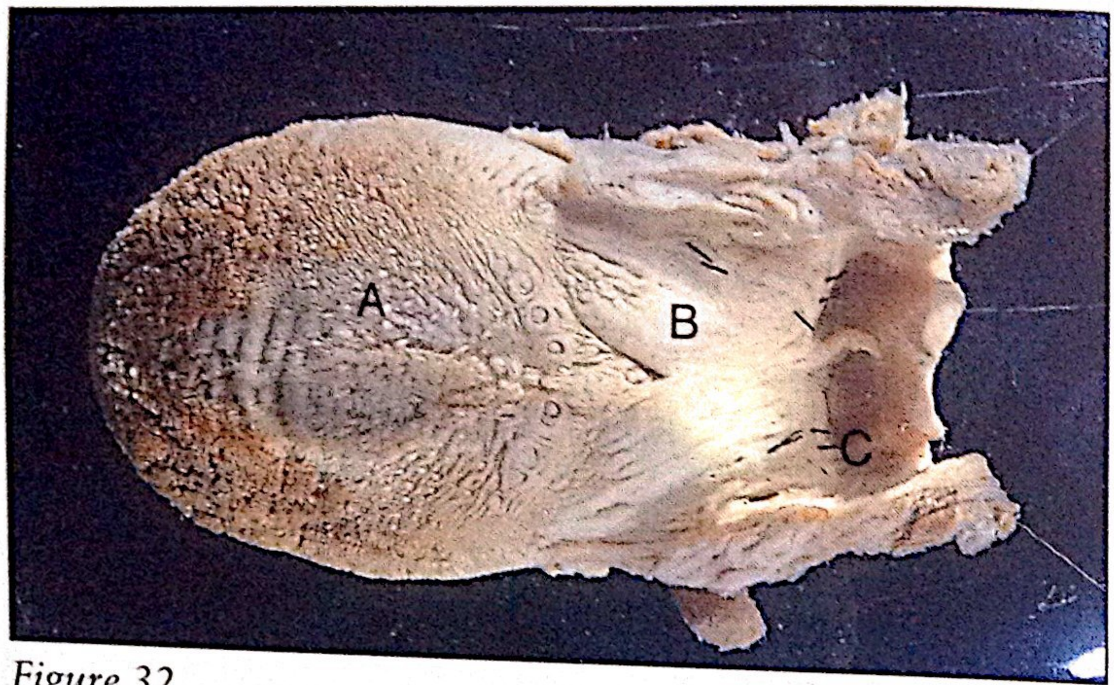


Figure 32

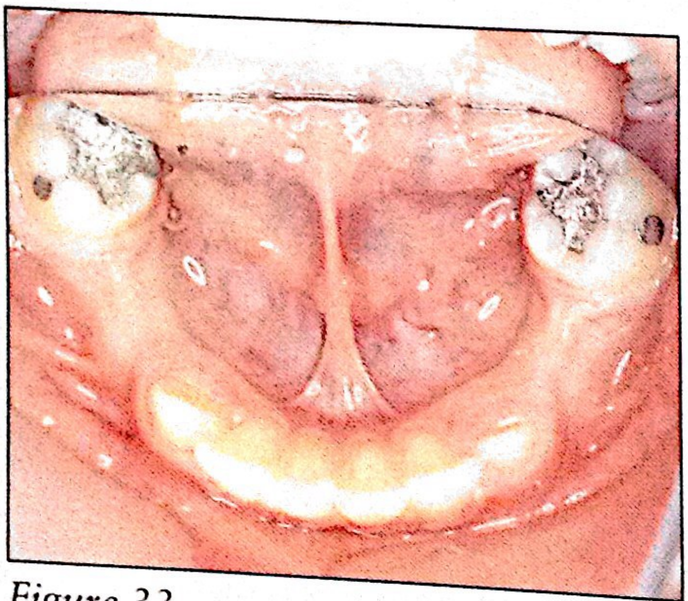


Figure 33

36 In the picture of the dorsum of the tongue provided, and for the various regions indicated, state the sensory innervation of the mucosa *(Figure 32)*. How would you explain this distribution in terms of the development of the tongue?

37 What is unusual about the appearance of the floor of the mouth shown here and what signs and symptoms would you expect? *(Figure 33)*

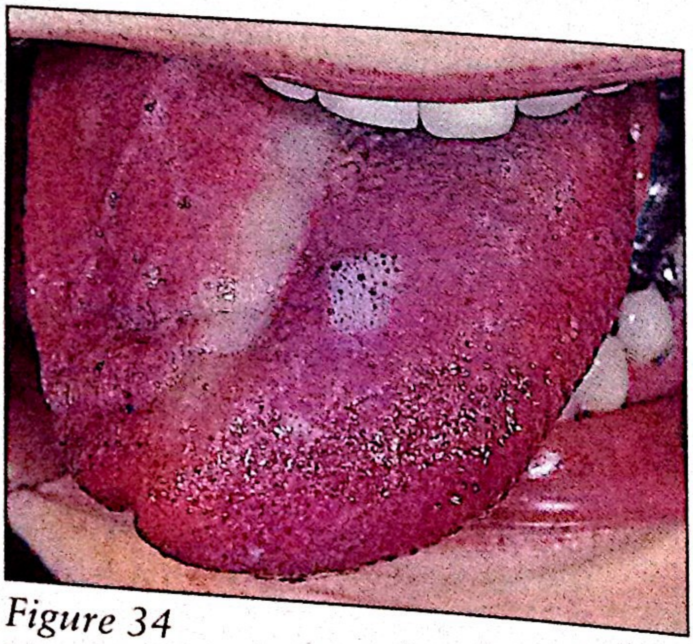


Figure 34

38 Three years after major surgery for a tumour in the left submandibular region, this patient was asked to protrude his tongue *(Figure 34)*. What has happened?

Palate

39 Which of the following statements are true:
(a) The hard palate develops endochondrally.
(b) The fibrous aponeurosis of the soft palate is derived from the expanded tendon of the levator veli palatini muscles.
(c) With the exception of palatopharyngeus, all the muscles of the soft palate are supplied by the pharyngeal plexus of nerves.
(d) The tensor veli palatini muscle arises in part from the scaphoid fossa of the sphenoid bone.
(e) A suture, the premaxillary suture, separates the premaxilla from the maxilla.
(f) The levator veli palatini muscle is intrapharyngeal, lying inside the upper margin of the superior constrictor.
(g) The pyramidal process at the back of the hard palate is part of the pterygoid plate of the sphenoid bone.
(h) The median palatine suture is seen on an intra-oral periapical radiograph of the maxillary central incisors.
(i) The glands of the palate receive their parasympathetic supply via the greater petrosal nerve of the facial.
(j) The palatopharyngeus muscle has two heads of origin.

40 *(Figure 35)*
(a) Identify A to F.
(b) What is the sensory innervation of the soft palate?

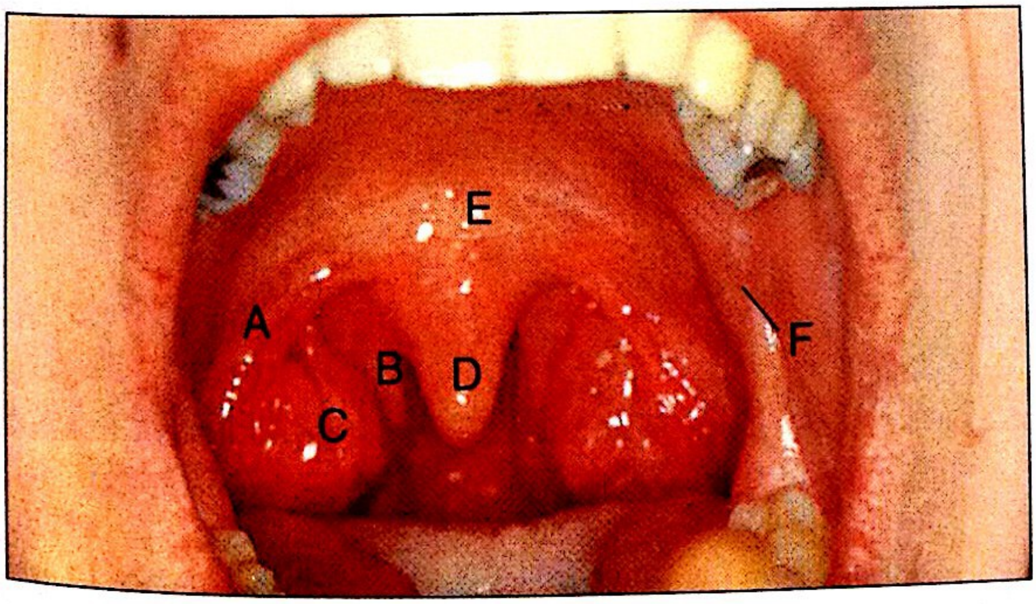


Figure 35

41 *(Figure 36)*

(a) What type of mucosa is found lining surfaces A, B and C?

(b) Identify structure D.

(c) A new clinical student carried out local infiltration anaesthetic techniques to extract a permanent maxillary central incisor in an apprehensive patient. He rapidly injected a 2ml cartridge of anaesthetic solution both labially and palatally and successfully and easily extracted the tooth. The next day the patient returned complaining of considerable pain in the palate. What might be the problem?

Figure 36

42 What is the significance of the structure arrowed near the midline of the palate? *(Figure 37)*

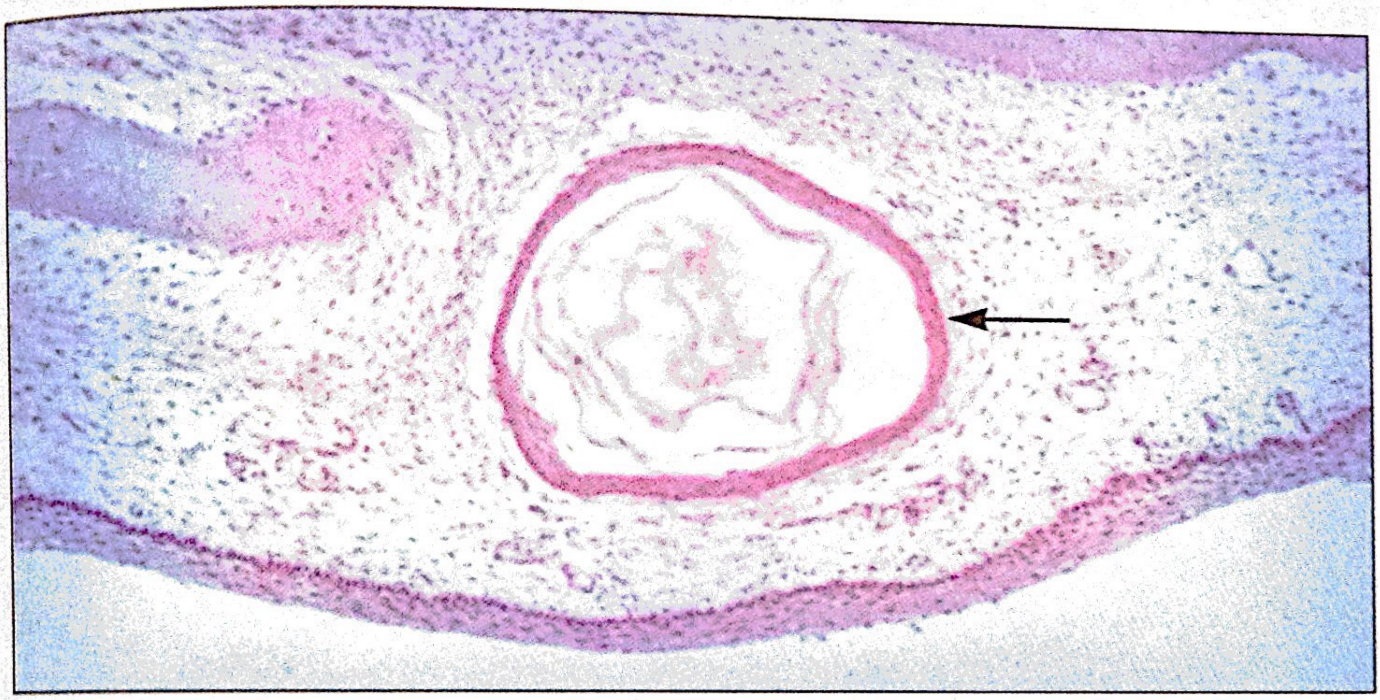


Figure 37

Face

43 Which of the following statements are true:

(a) There is little midline overlap of trigeminal sensory nerve fields on the face.

(b) The infra-orbital nerve supplies the skin of the upper lip, except over the philtrum.

(c) The depressor labii inferioris muscle arises from the mandible immediately above the mental foramen.

(d) The facial nerve carries secretomotor fibres to the parotid gland.

(e) The infra-orbital nerve enters the face between the levator anguli oris and the levator labii superioris muscles.

(f) The parotid duct lies above the transverse facial artery.

(g) The facial artery crosses the inferior border of the mandible at the anterior border of the masseter muscle.

(h) On the face, the anterior facial vein lies anterior to the facial artery.

(i) The external nasal nerve is the terminal branch of the anterior ethmoidal nerve.

(j) The buccinator muscle arises in part from the anterior border of the pterygomandibular raphe.

44

(a) In *Figure 38* describe the lymphatic drainage of and arterial blood supply to areas A, B, and C.
(b) In *Figure 39* what is the cutaneous innervation to areas A to F?

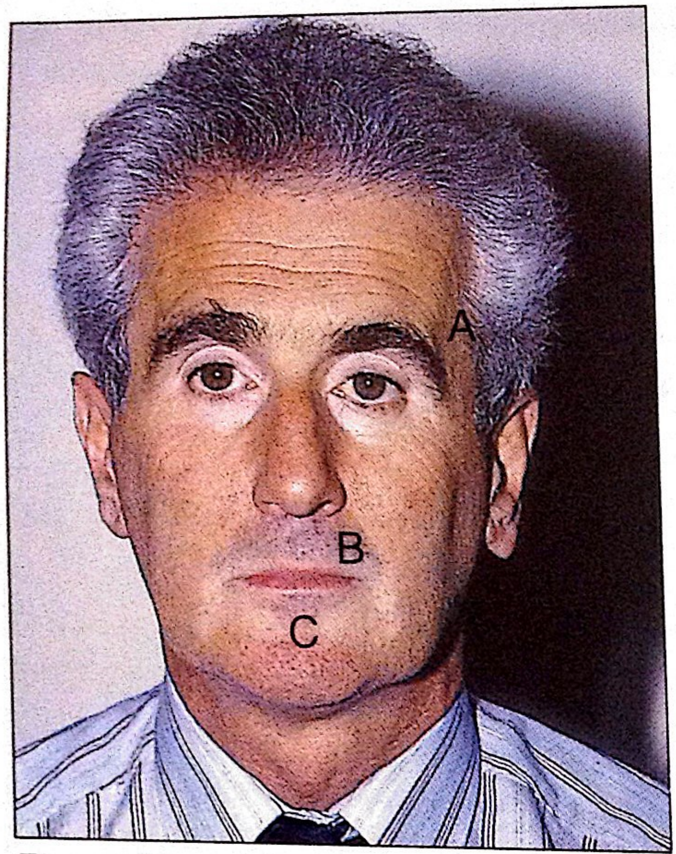


Figure 38

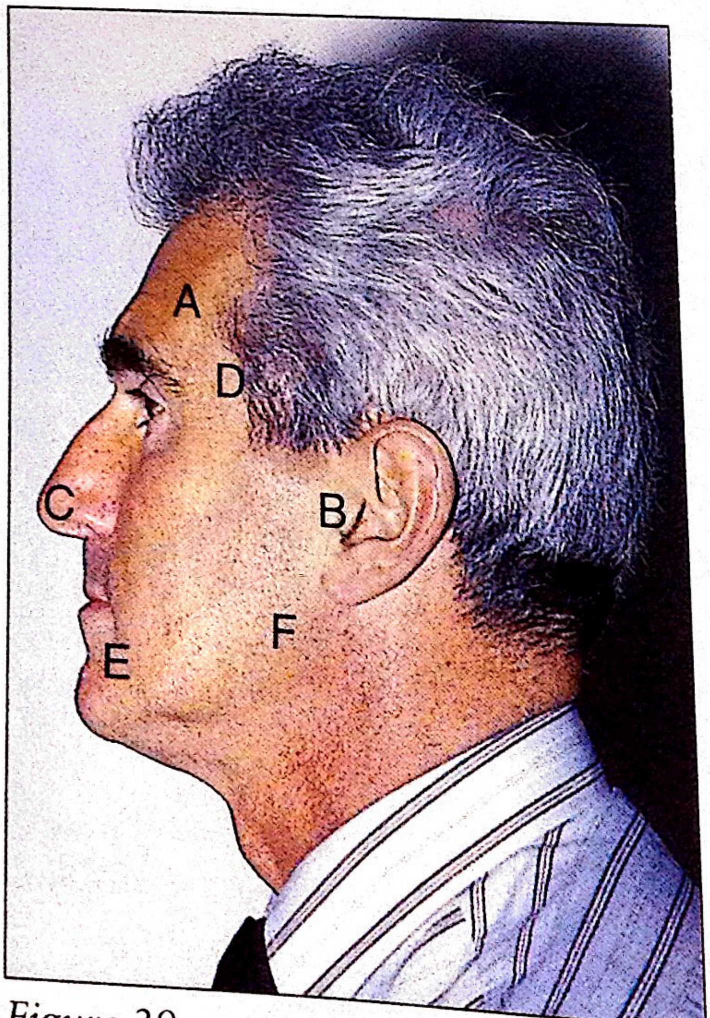


Figure 39

45 *(Figure 40)*

(a) Identify muscles A to G, indicating their precise nerve supply.

(b) Identify structures H to M.

(c) What is the important clinical significance of N?

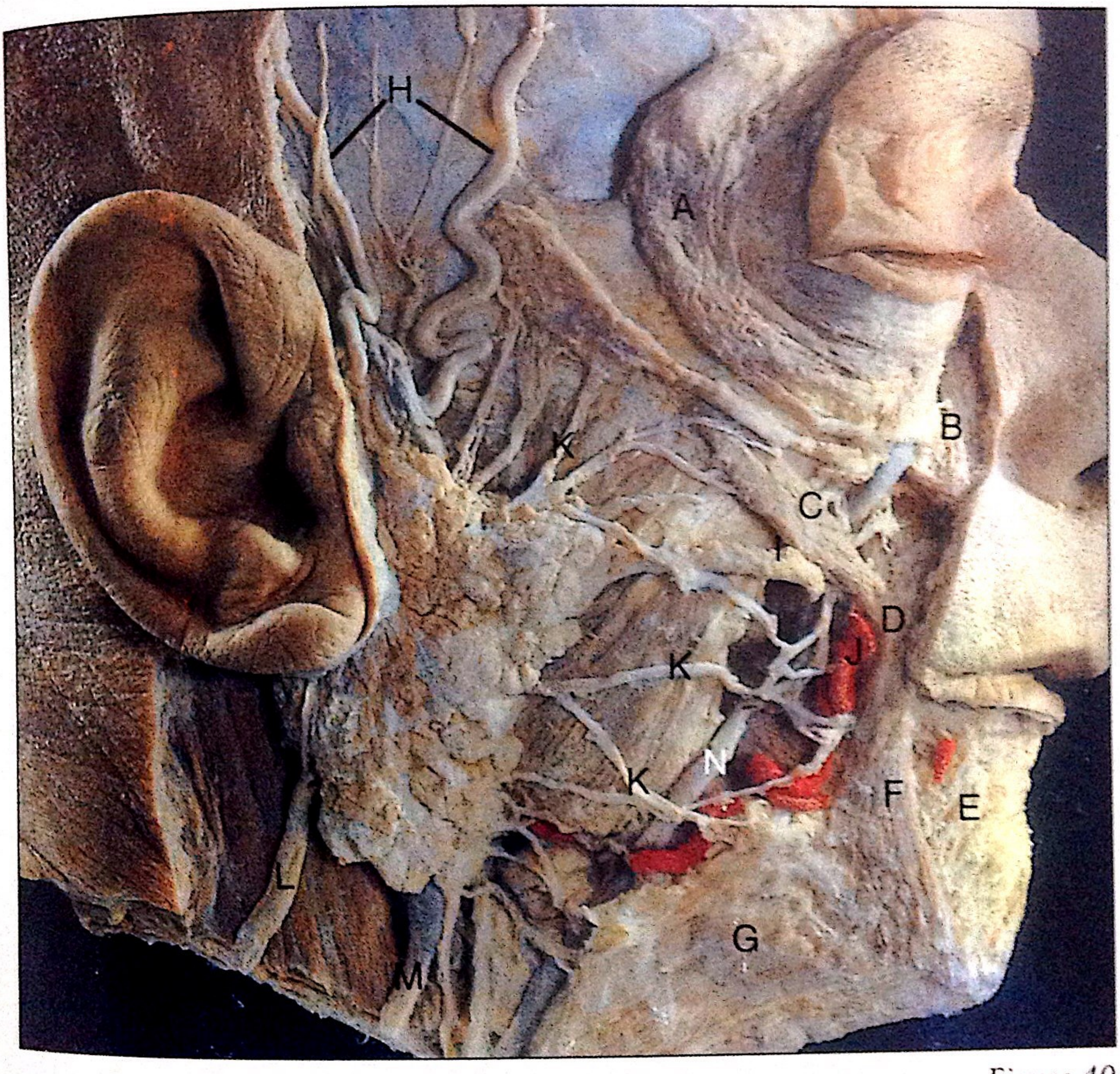
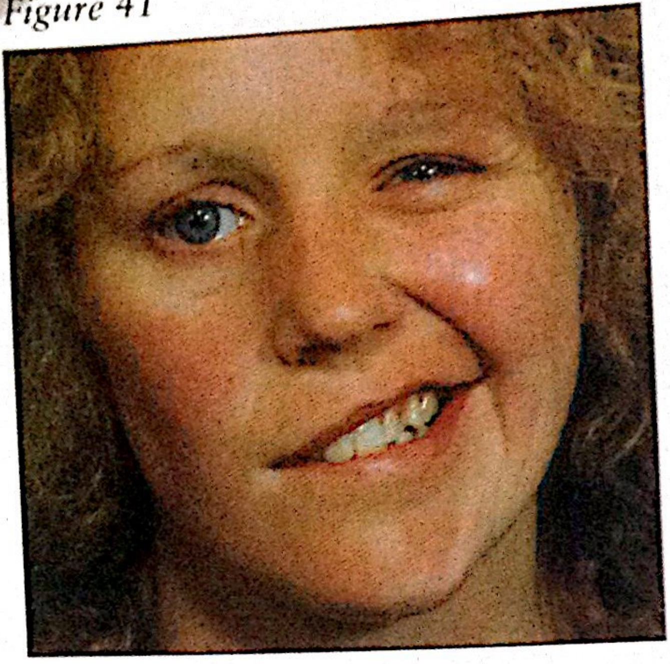


Figure 40

Figure 41



46 A young scientist returned from a scientific expedition to the Arctic. She had noticed that the right side of her face appeared distorted and was expressionless (*Figure 41*). On that side, she could not close her eye and was unable to smile properly. Also, she had difficulty in retaining food in her mouth while eating. What is responsible for these symptoms and what is the main danger to health?

47 A patient had full dentures made. The normal resting position of the patient without dentures is shown in *Figure 42* and following the fitting of the dentures in *Figure 43*. Is everything satisfactory?

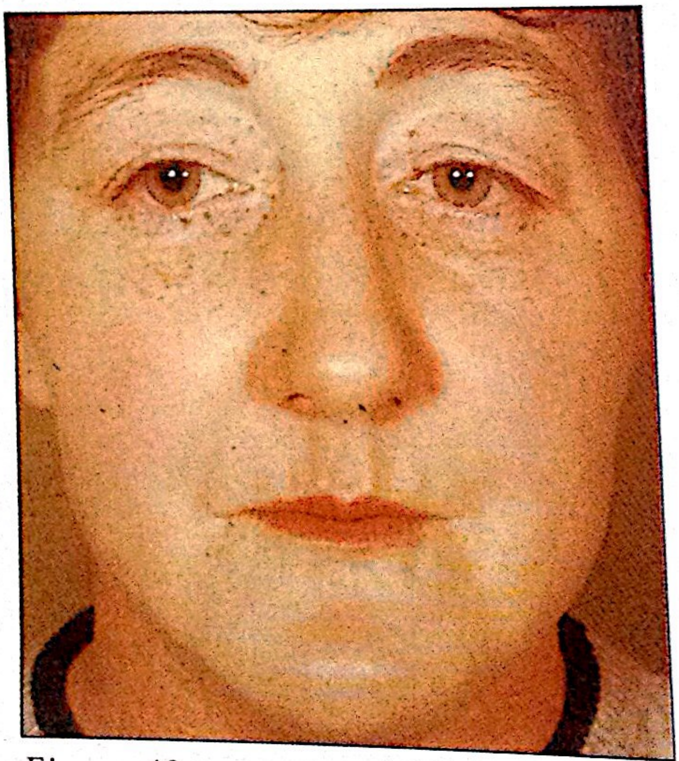


Figure 42

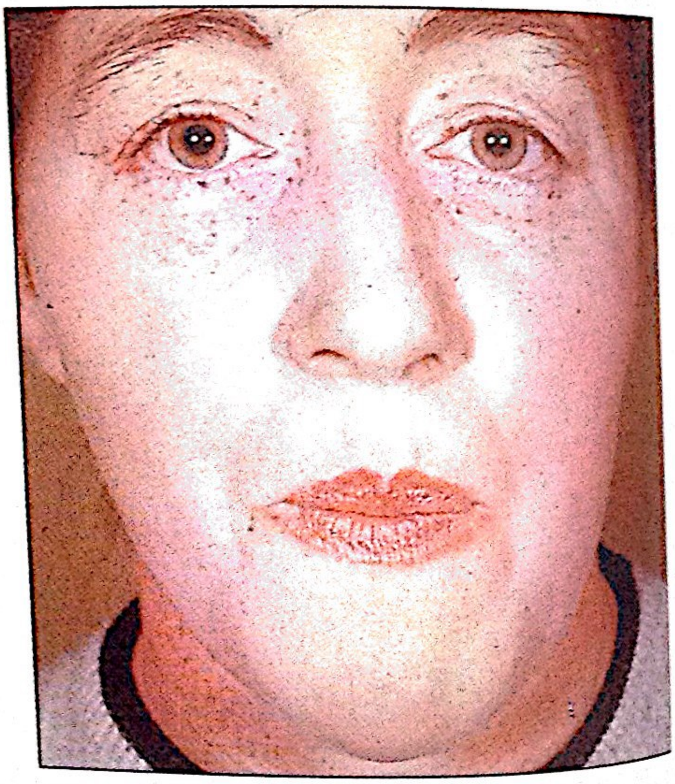


Figure 43

Deep Face (infratemporal fossa)

48 Which of the following statements are true:

(a) The infratemporal fossa is the region which lies deep to the ramus of mandible.

(b) The infratemporal fossa has no floor, passing down with the pharynx into the deep neck.
(c) The infratemporal fossa communicates with the pterygopalatine fossa through the inferior orbital fissure.
(d) The maxillary artery in the infratemporal fossa has, at its first part, the middle meningeal, inferior alveolar and deep temporal arteries as branches.
(e) The pterygoid venous plexus in the infratemporal fossa connects with the cavernous sinus intracranially by veins passing through the sphenoidal emissary foramen, foramen ovale and foramen spinosum.
(f) The inferior alveolar nerve in the infratemporal fossa is derived from the anterior trunk of the mandibular nerve, deep to the lateral pterygoid muscle.
(g) The lingual nerve in the infratemporal fossa lies anterior to, and slightly deeper than, the inferior alveolar nerve.
(h) The otic parasympathetic ganglion in the infratemporal fossa is secretomotor to the parotid gland.
(i) The lateral pterygoid muscle has two heads of origin, the upper of which arises from the lateral surface of the lateral pterygoid plate.
(j) The medial pterygoid muscle takes origin from the inner aspect of the angle of the mandible.

49 *Figure 44* is of the infratemporal fossa.
(a) Identify the structures labelled A to G.
(b) What are the boundaries of the infratemporal fossa?
(c) What are the functions of the two pterygoid muscles found within the infratemporal fossa?
(d) How can local anaesthetic solution, injected into the infratemporal fossa, pass into the orbit?

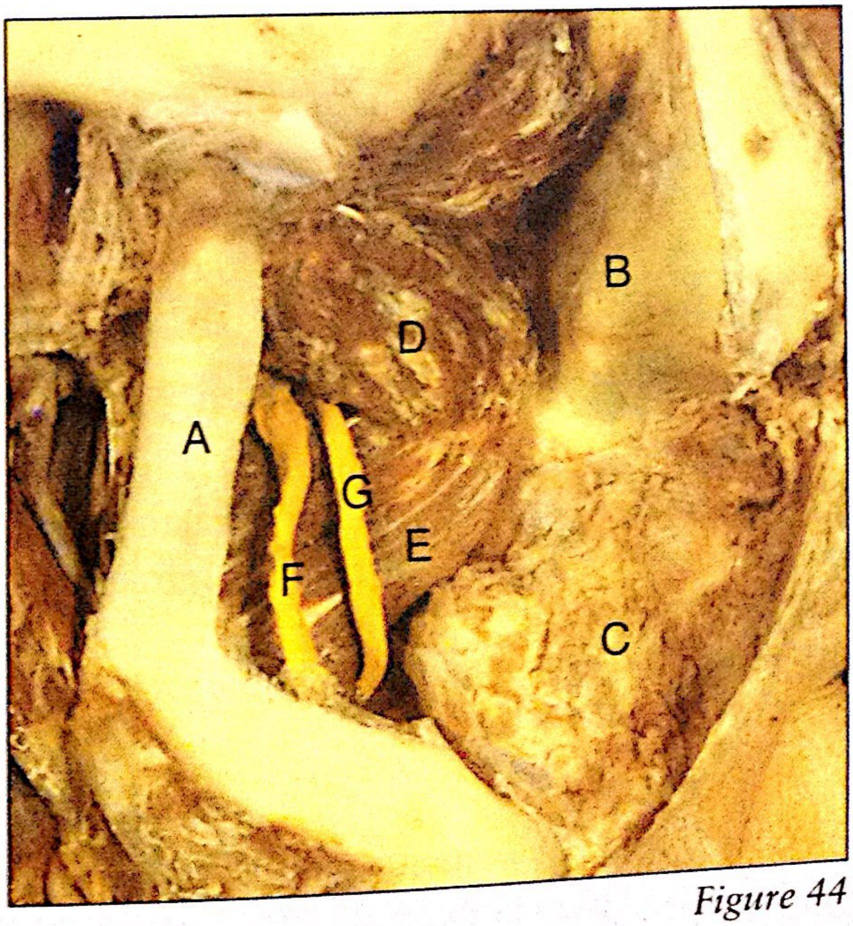


Figure 44

50 The accompanying picture is of a transverse section of the head *(Figure 45)*.
(a) Is this section taken through the infratemporal fossa at a high, middle, or low level?
(b) Label features A to H all of which are associated with the infratemporal fossa.

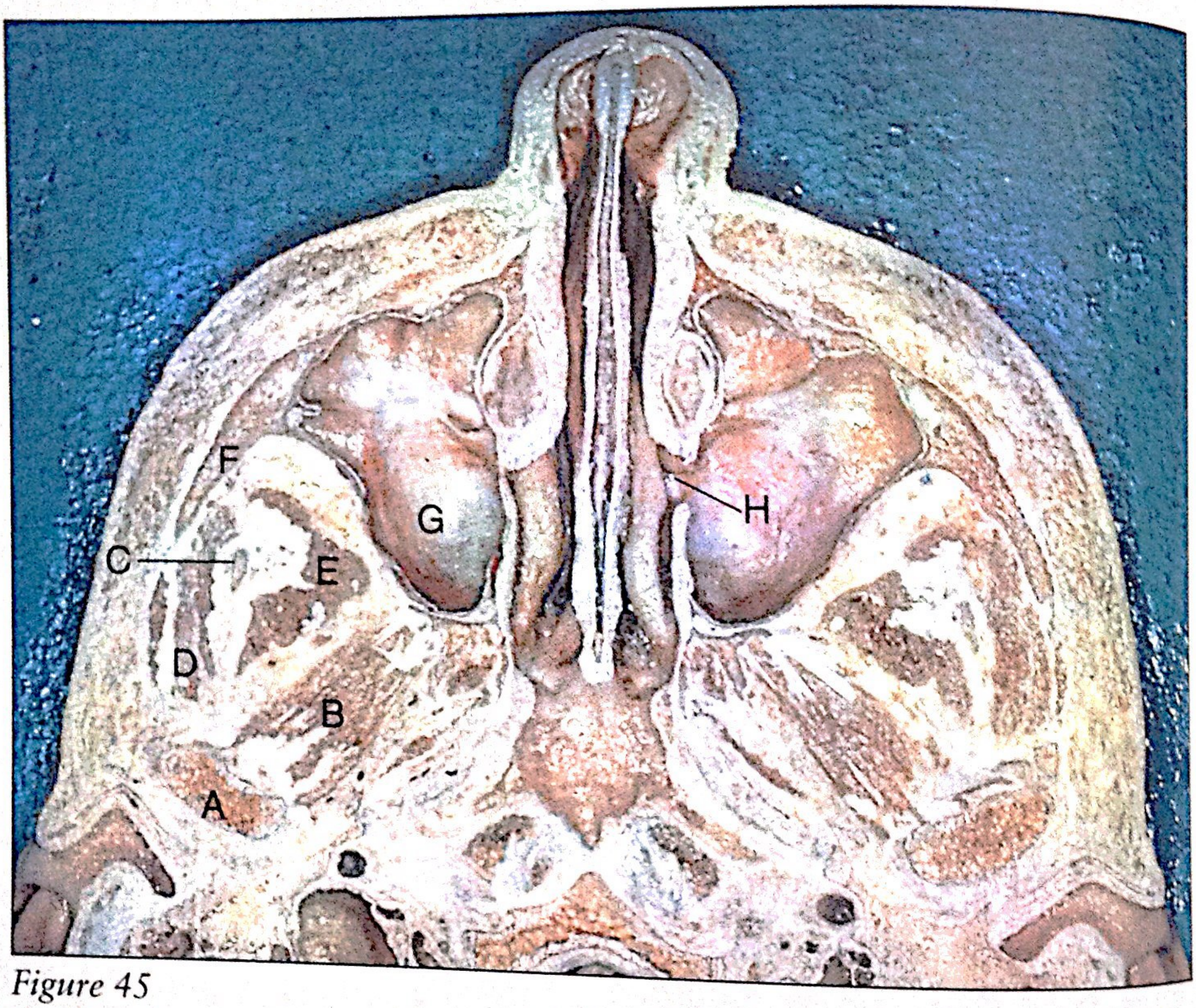


Figure 45

51 This is an MRI scan of the head *(Figure 46)*, representing a transverse section through the region of the infratemporal fossa.
(a) Is this section taken through the infratemporal fossa at a high, middle, or low level?
(b) Label features A to G all of which are associated with the infratemporal fossa.

52 A 45-year-old woman required a large gold inlay in her mandibular first molar tooth. To accomplish this, the inferior alveolar nerve was anaesthetised in the infratemporal fossa. The patient was discharged, but returned a few days later complaining of considerable difficulty in opening her mouth. She felt unwell and showed signs of fever. Trismus due to bleeding in the infratemporal fossa at the injection site was diagnosed. Which vessels are those most likely to be damaged? The fever indicates that the blood clot in the infratemporal fossa has become infected. What are the anatomical reasons for considering such infections to be dangerous to the well-being of the patient?

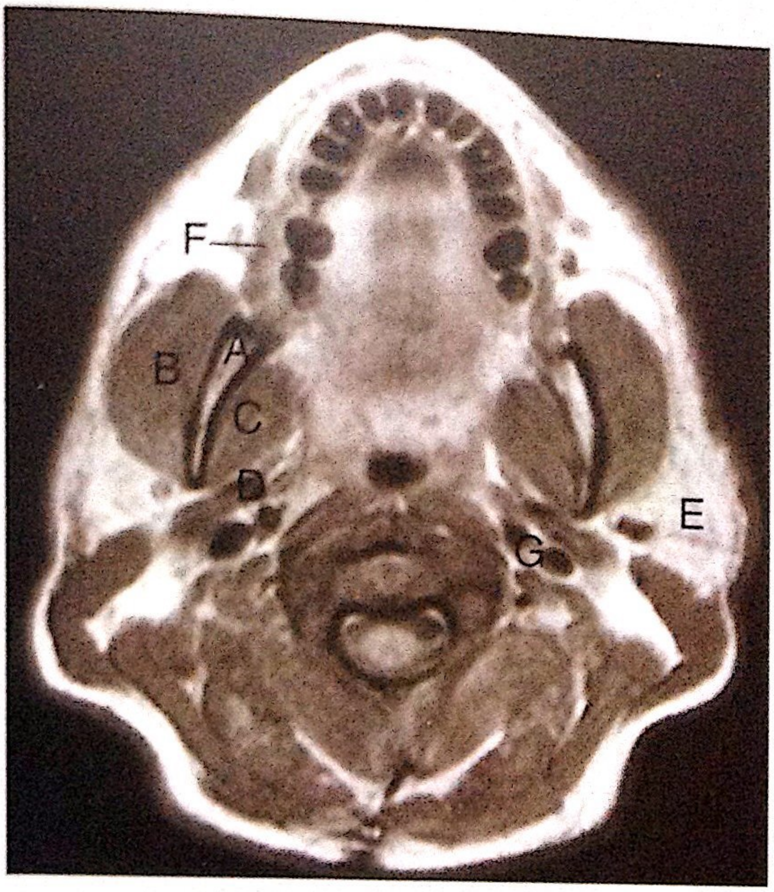


Figure 46

53 In order to anaesthetise the inferior alveolar nerve in the infratemporal fossa, it is often necessary to approach the nerve indirectly by a two-stage technique *(Figures 47 and 48)*. What are the anatomical reasons for this?

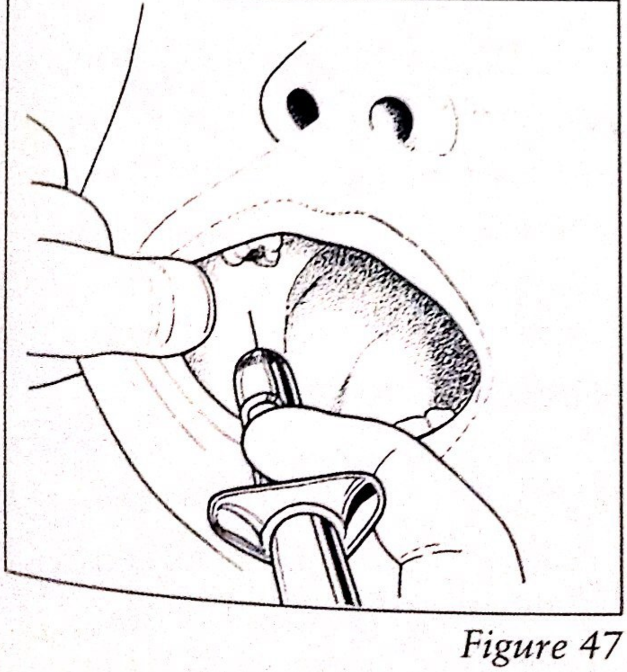


Figure 47

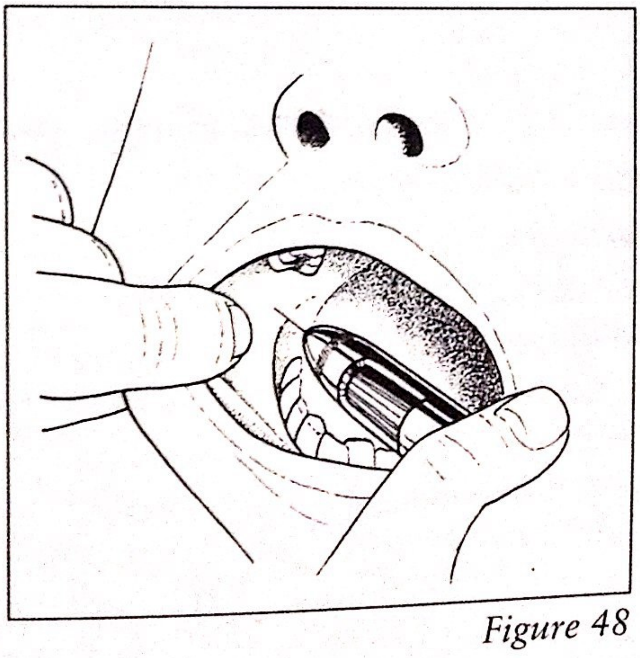


Figure 48

Temporomandibular Joint and Muscles of Mastication

54 Which of the following statements are true:

(a) The upper joint cavity of the temporomandibular joint is primarily associated with hinge movements of the mandible.

(b) Development of the temporomandibular joint begins about the 12th week of intra-uterine life.

(c) The articular disc of the temporomandibular joint gains an attachment anteriorly to the medial pterygoid muscle.

(d) Like other synovial joints, the articular surfaces of the temporomandibular joint are covered by hyaline cartilage.

(e) The bone of the mandibular (glenoid) fossa is thick in order to withstand the forces of mastication.

(f) The digastric muscle is a weak elevator and retractor of the mandible.

(g) The lateral pterygoid muscle has two heads, between which runs the lingual nerve.

(h) The two heads of the medial pterygoid muscle are separated by fibres of the lower head of the lateral pterygoid muscle.

(i) The masseter muscle is crossed anteriorly by the parotid duct and by branches of the facial nerve.

(j) The attachment of the temporalis muscle is limited above by the superior temporal line.

(k) The sensory supply to the temporomandibular joint is derived primarily from the great auricular nerve.

(l) The attachments of the articular capsule of the temporomandibular joint do not enclose the petrotympanic fissure.

(m) The nerve to the medial pterygoid muscle is derived from the anterior division of the mandibular nerve.

(n) The four primary muscles of mastication are derived embryologically from mesenchyme of the first pharyngeal (branchial) arch.

(o) The articular disc of the temporomandibular joint may undergo some chondrification with age.

(p) Lateral excursions of the mandible are the only bilaterally asymmetrical movements of this bone.

(q) As for the other muscles of mastication, the digastric muscle is innervated by the mandibular nerve.

(r) Occlusal imbalance may result in pain around the temporomandibular joint.

(s) The masseter is an example of a multipennate muscle.

(t) The capsule of the temporomandibular joint is strengthened medially by the temporomandibular ligament.

55 *(Figure 49)*

(a) Identify the muscles A, B, C, D, indicating their nerve supply.

(b) Identify structures E, F, G, H.

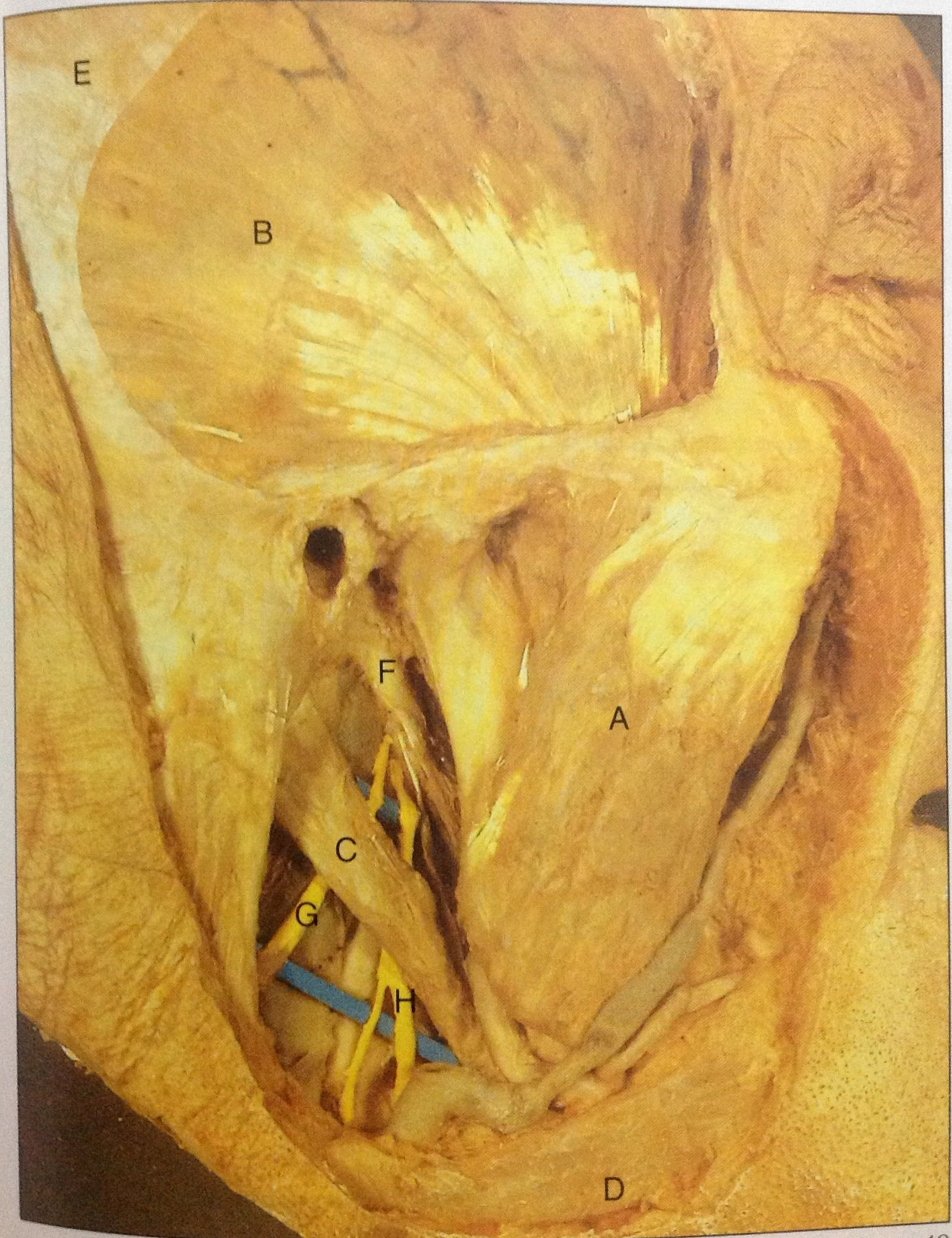


Figure 49

Figure 50

56 Identify the structures A to F. (*Figure 50*)

Figure 51

57 Identify A to G. (*Figure 51*)

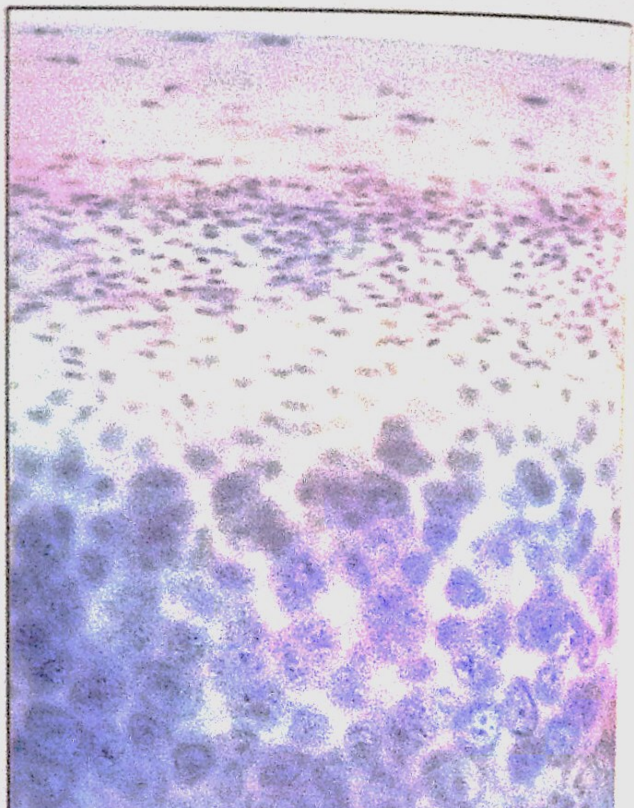


Figure 52

58 Is this from a young or an old person? (*Figure 52*)

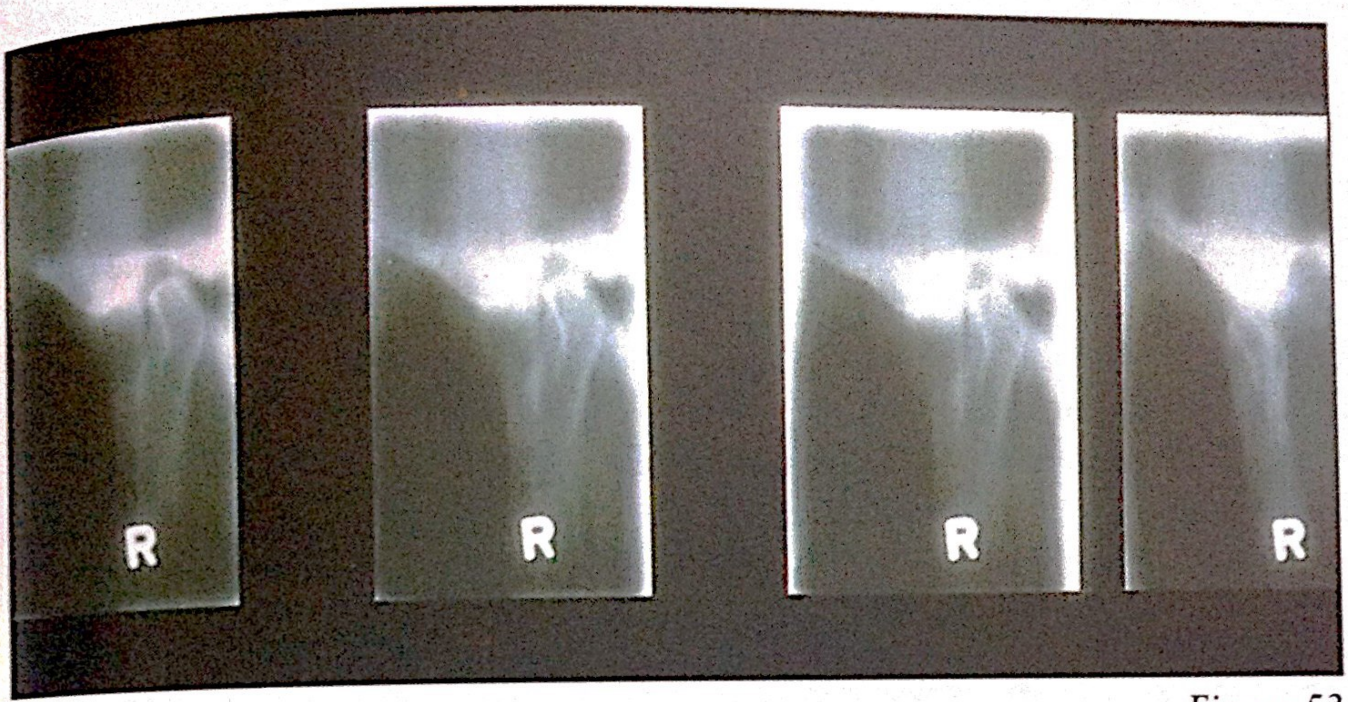


Figure 53

59 At the end of a lengthy visit to the dentist for the preparation of a complicated bridge, the patient became very distressed to find himself unable to close his mouth or speak properly. On examination, his chin appeared to be deviated towards the left. The accompanying figure *(Figure 53)* is a radiographic examination of the moving right condyle. What is the likely explanation of his symptoms?

60 A footballer was taken to hospital after being involved in a clash of heads during a match. On examination, the attending doctor observed that the region around the left ear was painful, swollen and exhibited some bleeding. On looking into the mouth, the teeth on the left side were seen to come into premature contact before those on the right side. Movement of the jaw was painful and, on opening, the jaw deviated to the left. A postero-anterior radiograph of the left ramus is shown here *(Figure 54)*. Explain the condition.

Figure 54

Tissue Spaces around the Jaws

61 Which of the following statements are true:

(a) Tissue spaces are merely potential spaces, being occupied in health by connective tissue or being closed by the apposition of bordering tissues.

(b) The tissue spaces around the jaws are defined primarily by membranous fascia.

(c) Most of the tissue spaces associated with the jaws are located in the retromandibular region.

(d) The buccal space is occupied in health by a well-defined pad of fat.

(e) The medial pterygoid muscle delineates the pterygomandibular and parapharyngeal spaces.

(f) The peritonsillar space lies in the upper part of the intrapharyngeal tissue space.

(g) The submandibular and submental tissue spaces are delineated by the digastric muscles.

(h) The palatine space is well-defined because of the copious submucosa in this region.

(i) Inflammatory products passing through the parapharyngeal and retropharyngeal regions can spread rapidly down the neck.

(j) Infections passing into the infratemporal fossa can affect the pterygoid venous plexus and thence spread to the cavernous sinus.

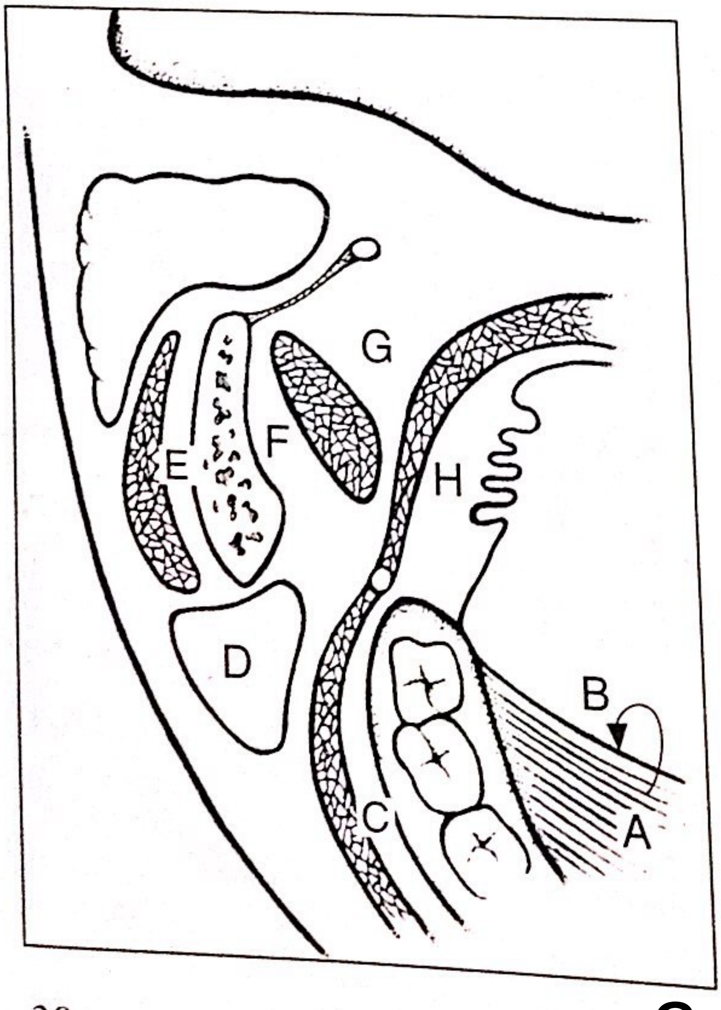


Figure 55

62 On the diagram of the retromandibular region provided (*Figure 55*):

(a) Identify the tissue spaces labelled A to H.

(b) Why are abscesses in the region labelled E difficult to drain?

63 The diagram provided *(Figure 56)* depicts the region of the tongue and the floor of the mouth as seen in a coronal section.

(a) Identify the tissue spaces labelled A, B and C.

(b) How may pus in the tissue space labelled B pass into the space labelled C?

(c) Why are infections in the tissue space labelled C usually restricted in their spread down into the anterior neck and why is this of potential danger to the patient?

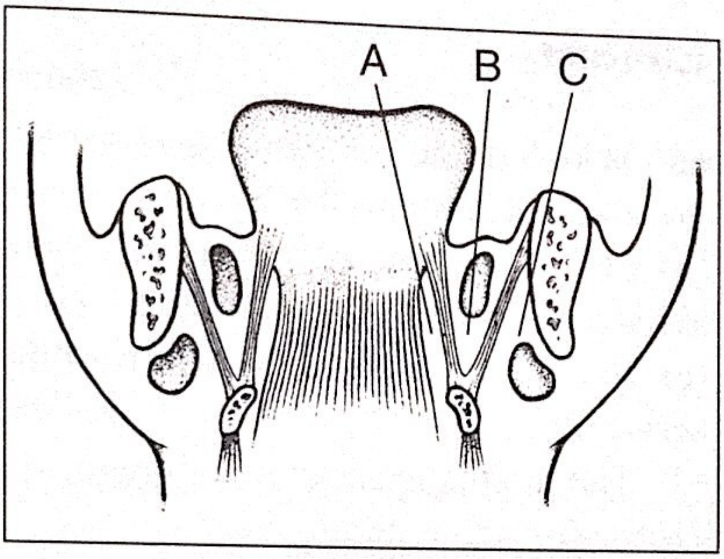


Figure 56

64 *(Figure 57)*
Identify the tissue spaces labelled A to D and name the adjacent muscles which define them.

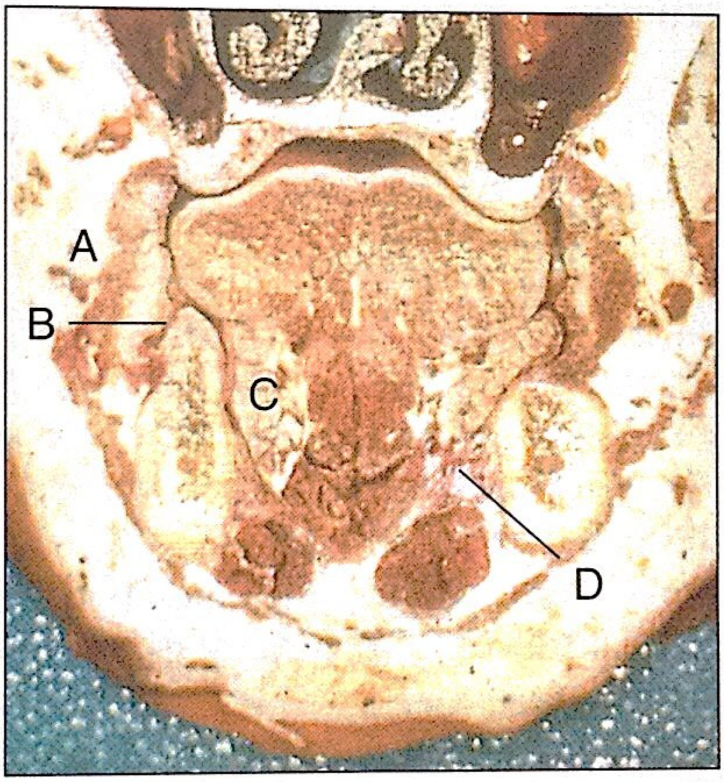


Figure 57

65 A patient with an abscess associated with a maxillary molar fails to visit the family dentist for treatment. Overnight, the abscess spreads into the face and buccal region *(Figure 58)*. Next morning, the dentist treats the tooth to effect drainage of the abscess and prescribes antibiotics. The dentist also warns the patient that this time he was lucky since the infection in the face could have spread to produce an intracranial abscess. How anatomically is this possible?

Figure 58

66 Which of the following statements are true:

(a) Enamel contains 4% by weight of organic matrix.

(b) Hydroxyapatite crystals in enamel are flattened hexagonal rods of average thickness about 30nm.

(c) In pattern 3 enamel, the heads of the prisms point occlusally and the tails cervically.

(d) The prismatic structure of enamel is not evident carefully in demineralised sections.

(e) Enamel prisms run a straight course from the enamel–dentine junction to the surface enamel.

(f) Fluorapatite dissolves more slowly in acid than hydroxyapatite.

(g) Enamel matrix is evenly distributed throughout the tissue.

(h) The diameters of enamel prisms are twice as large at the surface as at the enamel-dentine junction.

(i) Enamel spindles are present in greatest numbers beneath the cusps or incisal margins.

(j) Gnarled enamel is found primarily at the cervical margin.

(k) Dental calculus is calcified plaque and/or pellicle.

(l) Deciduous enamel appears whiter than permanent enamel due to its being more opaque.

(m) Pattern 1 enamel is the most widely distributed type of human enamel.

(n) Enamel over the cusps of permanent teeth can reach a maximum thickness of 1mm.

(o) Polarised light highlights prism boundaries because it can demonstrate changes in crystallite orientation.

(p) Hunter-Schreger bands are prominent in the outer third of enamel.

(q) Enamel matrix in adult enamel consists primarily of enamelins (non-amelogenins).

(r) Enamel spindles project inwards between 10 – 40μm from the enamel surface.

(s) Throughout its life, the crown of a tooth is covered by an organic integument.

(t) Enameloid can be regarded as a hypercalcified layer of specialised dentine.

67 *(Figure 59)*

(a) Identify the oblique lines (arrow heads).

(b) Is this a longitudinal or transverse section of enamel?

(c) Which of the borders (A or B) is more cervical?

(d) What is the approximate time gap between two adjacent oblique lines?

(e) Are the oblique lines spaced regularly apart throughout enamel?

(f) What structural features are represented by the arrows, and are such structures found all over the enamel surface?

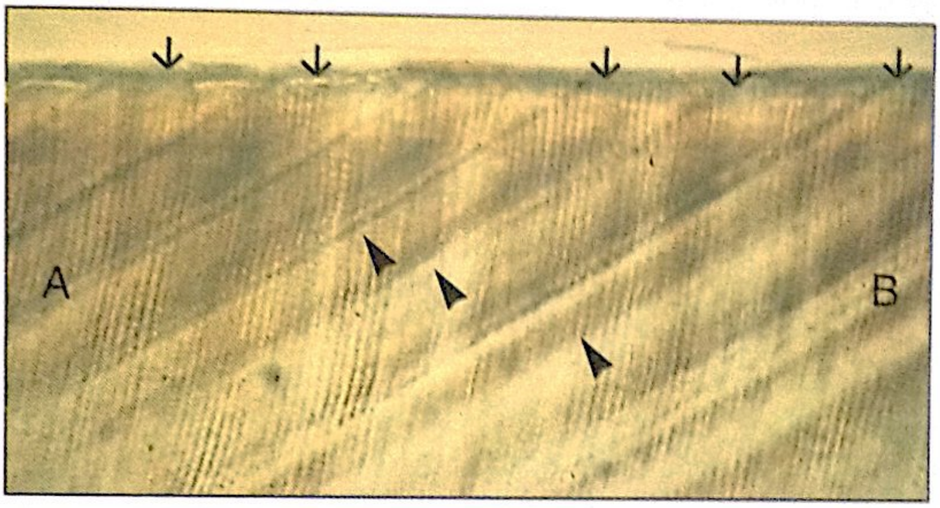


Figure 59

68 *(Figure 60)*

(a) Identify structures A, B and C.

(b) Has this ground section been cut longitudinally or transversely?

(c) How could you determine whether C was a definite structure or an artefact?

(d) Would structure A be retained following demineralisation?

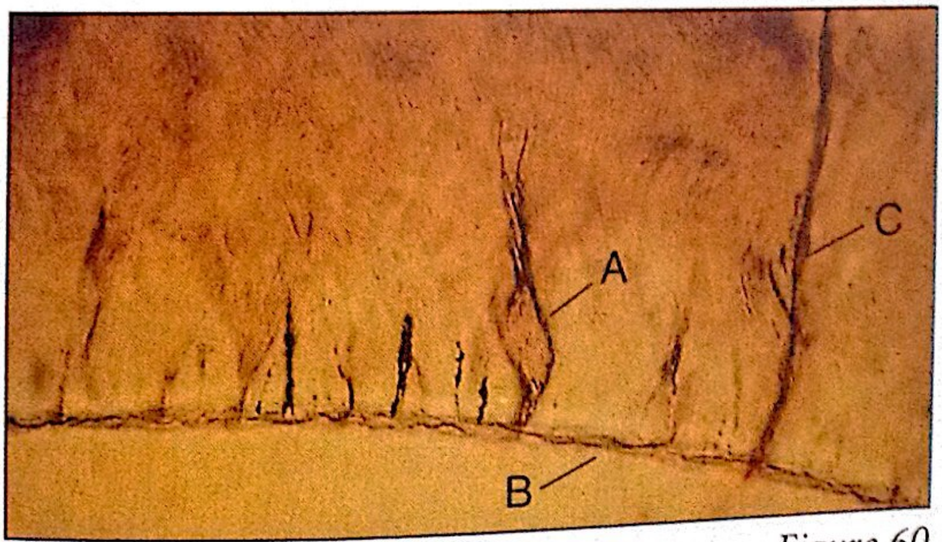


Figure 60

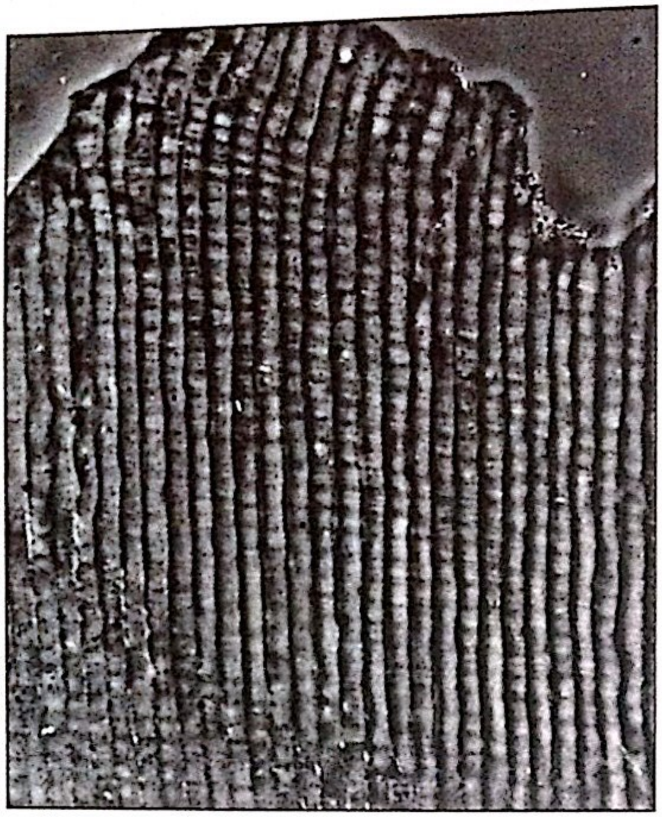


Figure 61

69 *(Figure 61)*

(a) Identify the vertical lines, giving their distance apart.

(b) What produces the appearance of these lines?

(c) Are these lines present in all mammalian enamel?

(d) What is the thickness of these lines in the light microscope and in the transmission electron microscope?

(e) Identify the horizontal lines.

(f) Are the structures identified in part (e) visible with the transmission electron microscope and are they evenly spaced?

70 *(Figure 62)*

(a) Identify zone A in this scanning electron micrograph.

(b) Account for its appearance compared with the zone B.

(c) Are there any differences between zone A in deciduous and permanent teeth?

(d) Are there any physico-chemical differences between zones A and B?

(e) Why is a knowledge of etching patterns in zone A important?

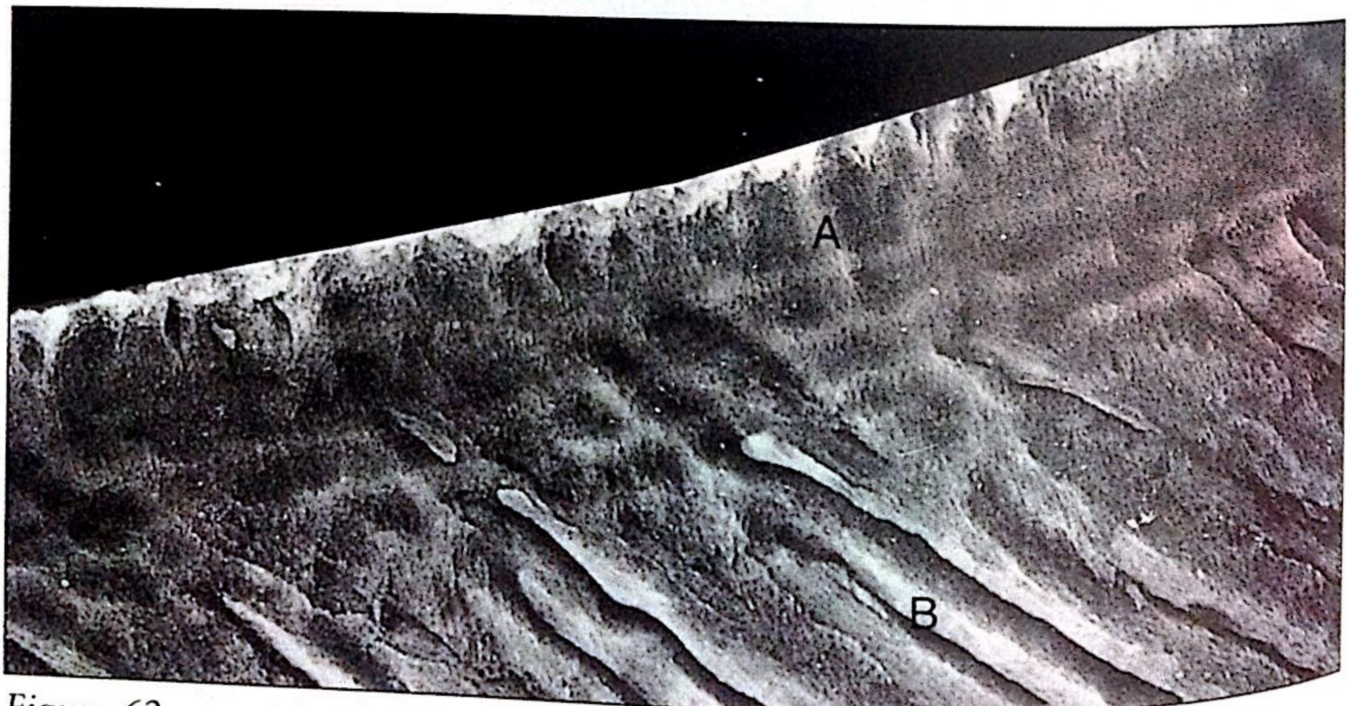


Figure 62

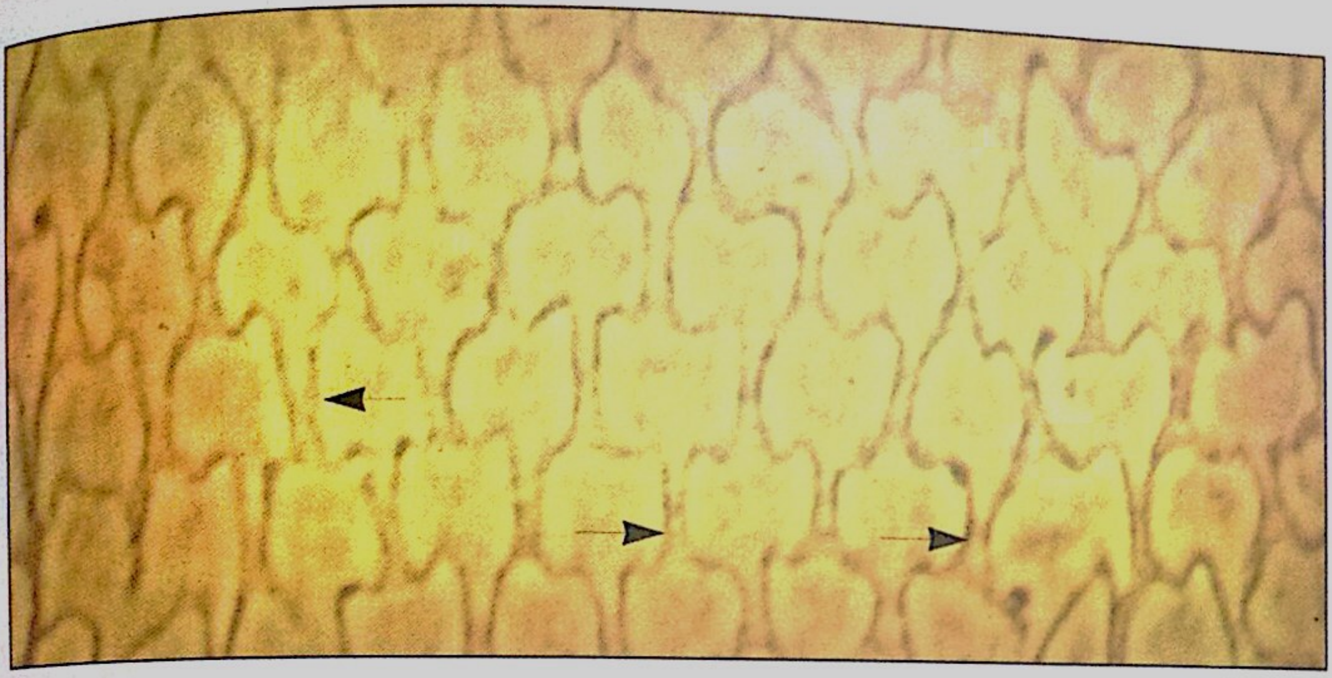


Figure 63

71 This is a ground section of enamel *(Figure 63)*.
(a) Are the basic structural units illustrated here cut transversely or longitudinally?
(b) Classify this pattern of enamel.
(c) What is the average dimension of the bar indicated?
(d) What is the main explanation given to account for the appearance of the boundaries (arrowed)?
(e) Is the occlusal surface of the tooth in a direction towards the top of the micrograph or towards the bottom?

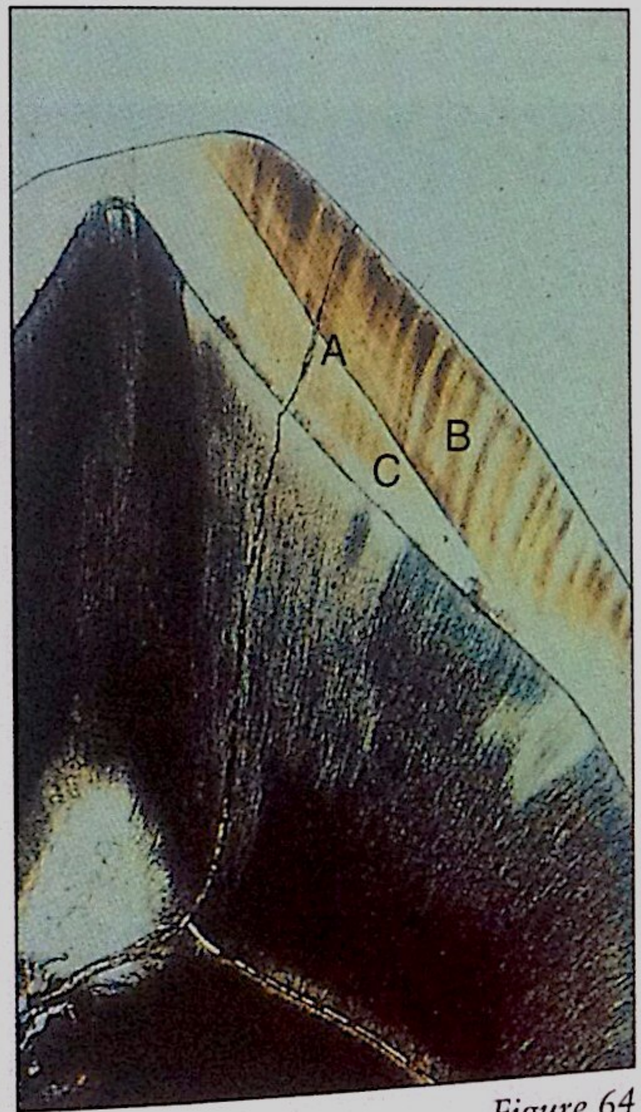


Figure 64

72 *(Figure 64)*
(a) Identify the structure A in this longitudinal ground section of a deciduous canine.
(b) Which region of enamel is the oldest, that in zone B or that in zone C?
(c) Do all teeth exhibit structure A?
(d) Is the degree of occlusal wear present, typical for such teeth?

73 If the relatively clear zone labelled B in this recently erupted tooth is at the level of the gingival crevice, account for the staining seen above (zone A) and below it (the stain used is alcian blue-aldehyde fuchsin). *(Figure 65)*

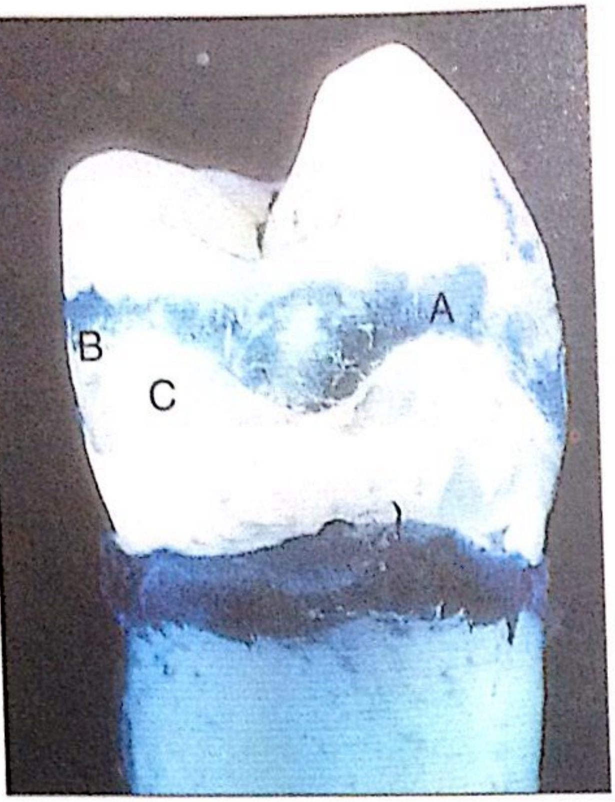


Figure 65

74 Identify A, B, and C. *(Figure 66)*

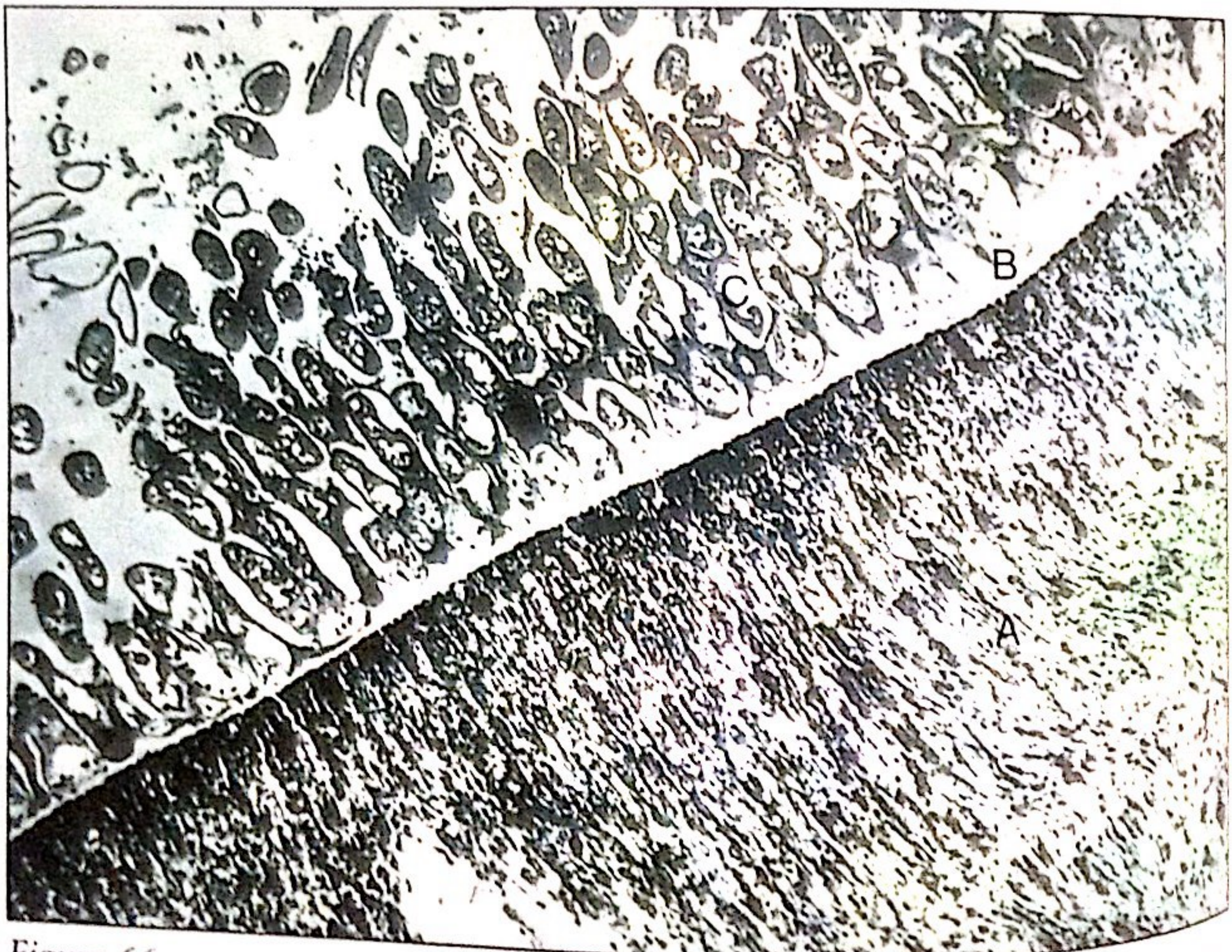


Figure 66

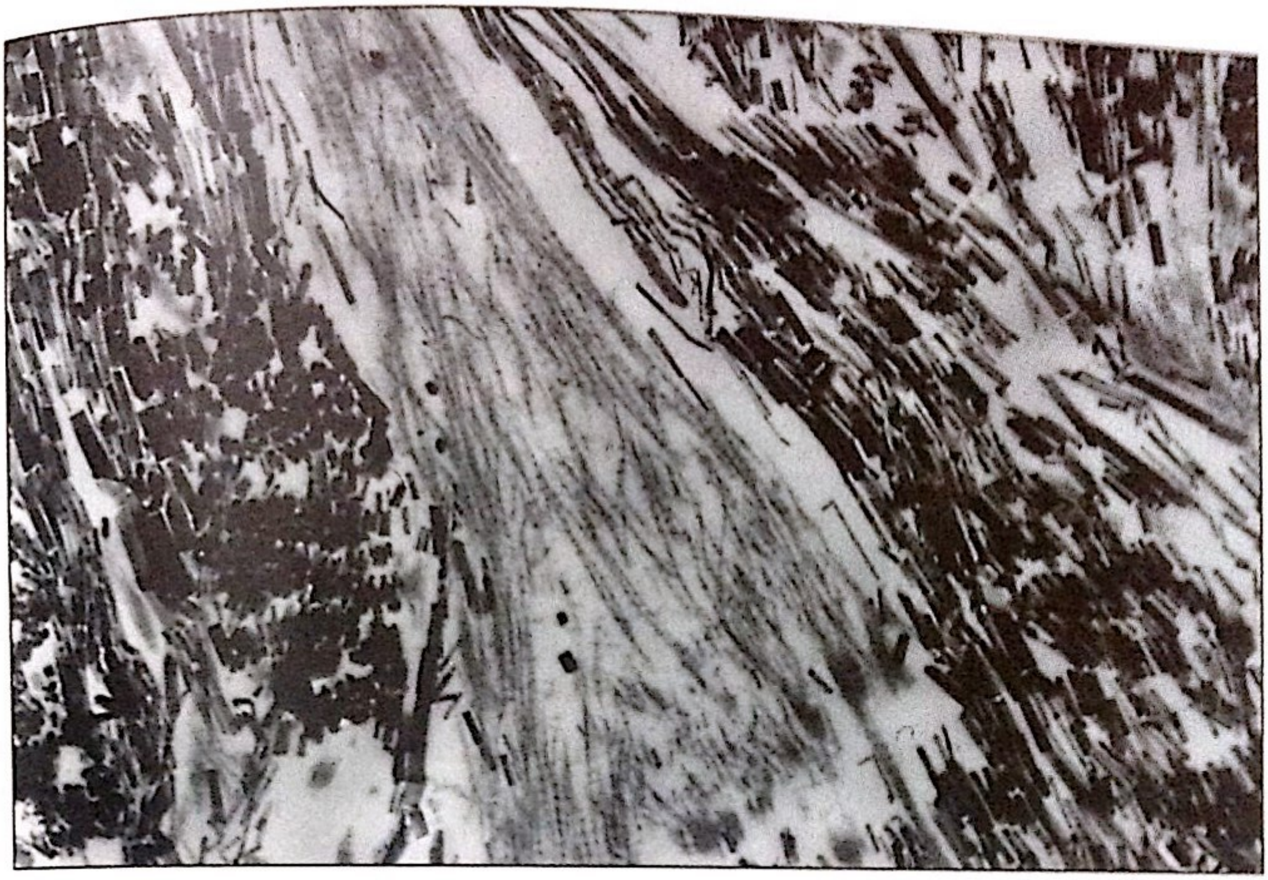


Figure 67

75 This is an electronmicrograph of developing enamel *(Figure 67)*. From which group of animals is it likely to come?

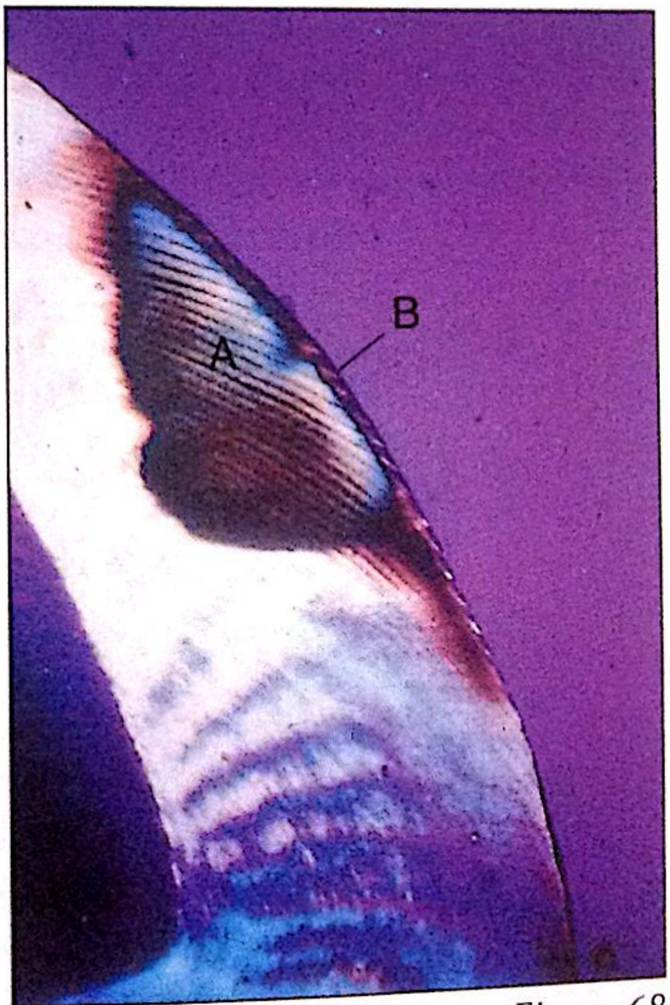


Figure 68

76 *(Figure 68)*

(a) What pathological process is occurring in the enamel in this ground section viewed in polarised light?

(b) What is happening in zone A?

(c) What structural features are particularly prominent in zone A?

(d) What is the significance of layer B?

77 Which of the following statements are true:

(a) On a wet weight basis, dentine contains 70% inorganic material, 18% organic material and 12% water.

(b) The hydroxyapatite crystals in dentine are of the same size as those in dental enamel.

(c) The primary curvatures in dentine represent daily incremental lines.

(d) The dentinal tubule always contains an odontoblastic process and this passes from the pulp–dentine border to the enamel–dentine junction.

(e) Predentine is hypomineralised in relation to the remaining dentine.

(f) Collagen fibres in the circumpulpal dentine generally run parallel to the dentinal tubules.

(g) Peritubular dentine is hypomineralised compared to intertubular dentine and has few collagen fibres.

(h) Peritubular dentine increases in thickness with age.

(i) Interglobular dentine lies near the enamel–dentine border and results from incomplete fusion of calcospherites.

(j) Nerves have not been identified entering dentine.

(k) Dentine in human teeth is highly vascular.

(l) The granular layer (of Tomes) at the cement–dentine border is a region produced by terminal dilations of dentinal tubules.

(m) Von Ebner's lines are incremental and represent a 5 day cycle of dentine formation.

(n) A dead tract occurs when the dentinal tubules in that region become completely obliterated by peritubular dentine.

(o) The pulps of deciduous teeth are relatively larger than those in permanent teeth.

(p) The only sensation appreciated from the pulp is pain.

(q) With age, the odontoblasts lining the pulp-dentine border become pseudostratified.

(r) Raschkow's nerve plexus lies between the odontoblasts and the predentine.

(s) Discrete regions of the pulp may calcify to produce pulp stones and these always take on a tubular, dentine-like appearance.

(t) Irregular secondary dentine results from a noxious stimulus applied to the pulp.

78 *(Figure 69)*
(a) Identify the features labelled A, B and C in this section through dentine.
(b) Is this a ground or a decalcified section through dentine? Give reasons for your answer.
(c) Where in the dentine is branching of the dentinal tubules particularly marked?
(d) List the possible contents of a dentinal tubule.
(e) In addition to orthodentine (ie tubular dentine), what other types of dentine are found in the animal kingdom?

79 *(Figure 70)*
(a) Identify the features labelled A to D at the cement–dentine junction.
(b) What is the thickness of layer C?

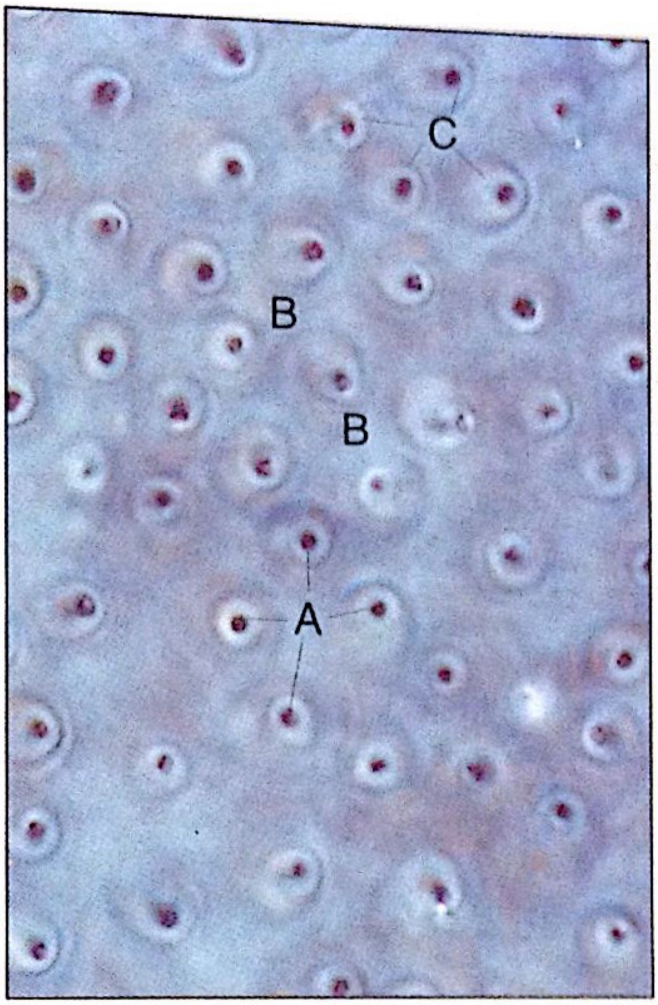


Figure 69

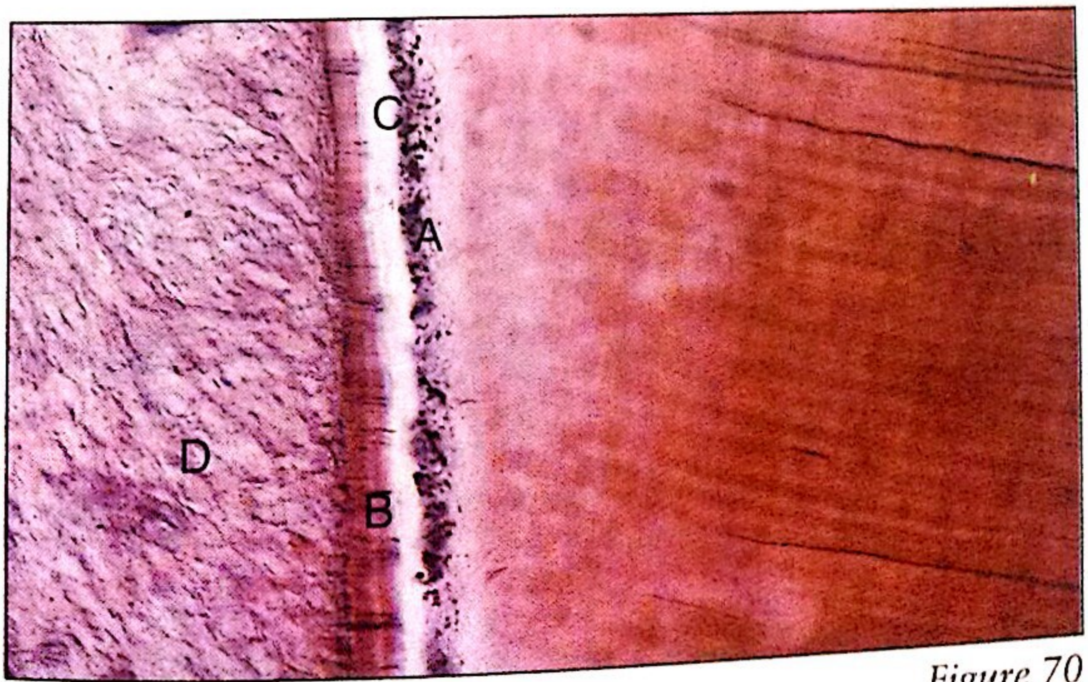


Figure 70

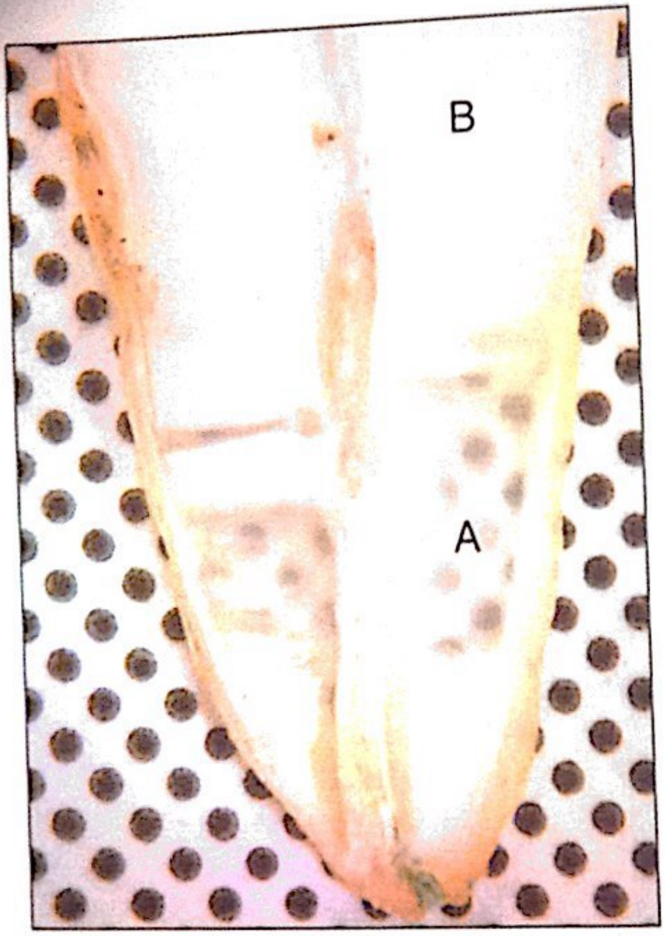


Figure 71

80 This micrograph is of a ground section of the root of a tooth immersed in water *(Figure 71)*.
(a) Is this section of a young or an old tooth?
(b) Account for the difference in appearance between areas A and B.

81 The ground section of the crown illustrated *(Figure 72)* shows the enamel-dentine junction (arrow).
(a) Identify the dark areas (A).
(b) Account for their formation.
(c) What is their relationship with peritubular dentine?
(d) Name one condition where this feature may be particularly conspicuous.

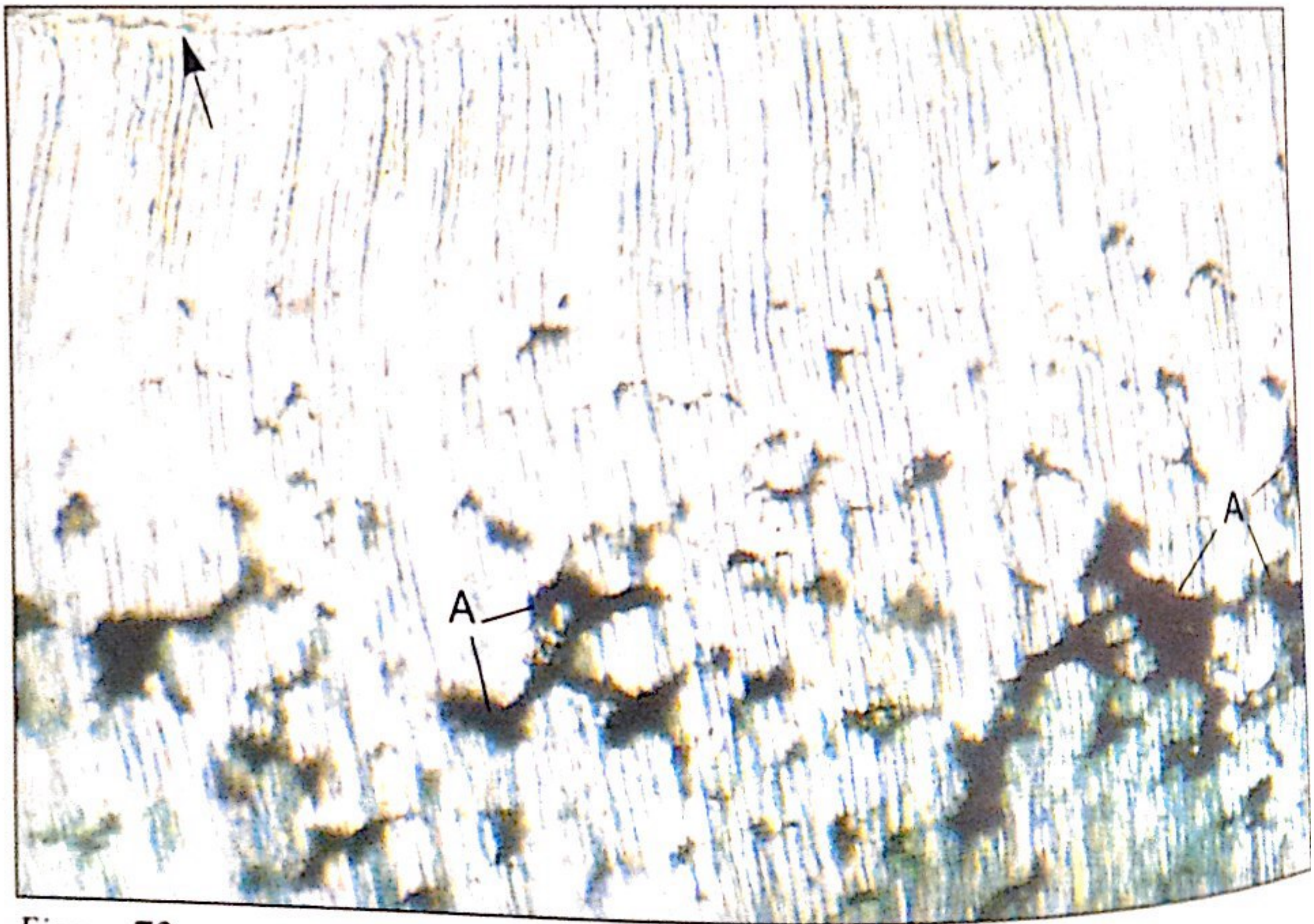


Figure 72

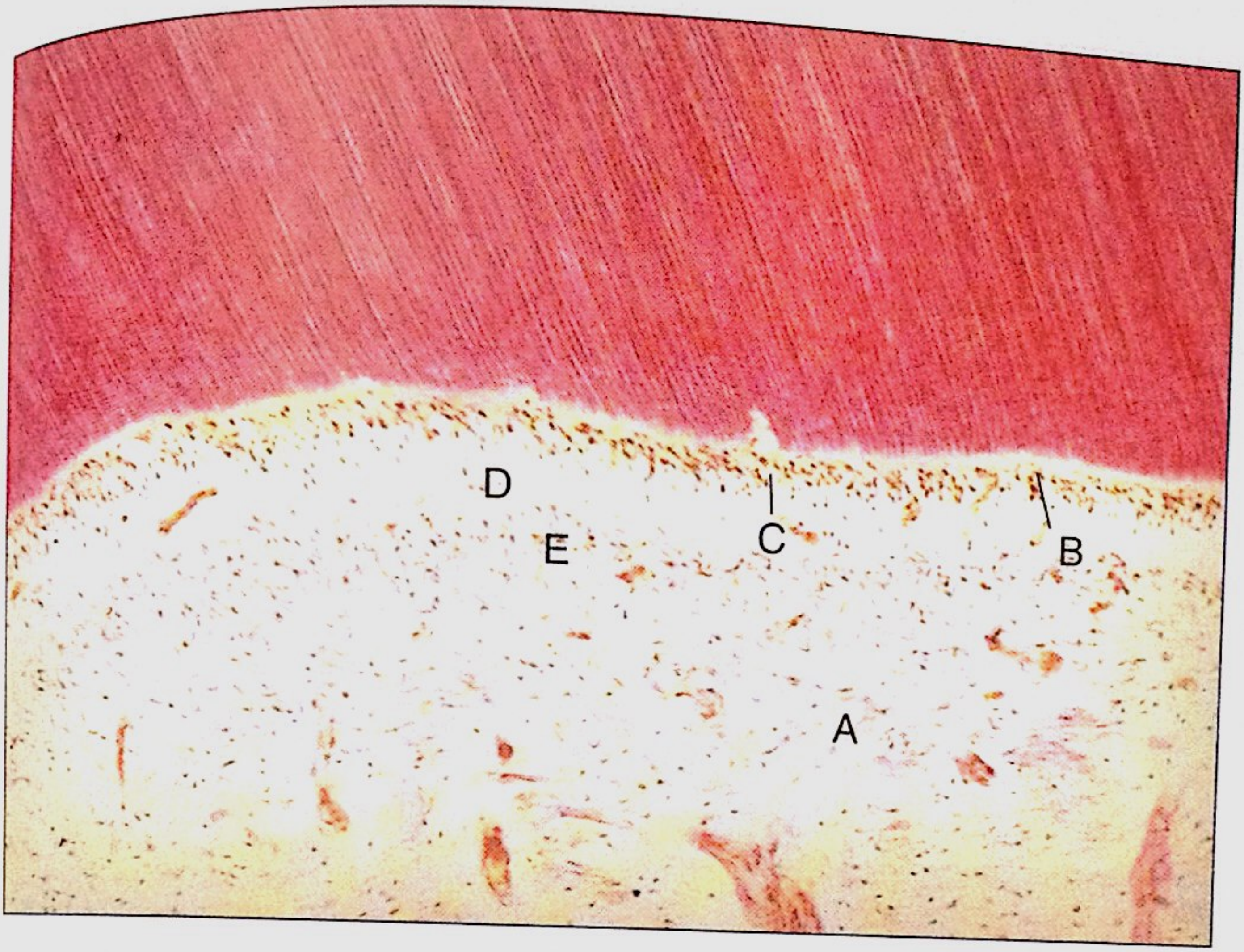


Figure 73

82 *(Figure 73)*

(a) Identify the features of the pulpodentinal complex labelled A to E.

(b) The micrograph shows a decalcified section stained with Toluidine blue. Why does layer A and layer B stain differently?

(c) What are the main ultrastructural features of an odontoblast cell body?

(d) What changes in the pulpodentinal complex occur with age?

83

(a) Briefly outline the three main theories proposed to explain dentine sensitivity.

(b) How would you test the notion that fluid movements within the dentinal tubules influence dentine sensitivity?

Figure 74

84 *(Figure 74)*

(a) Identify the horizontally disposed lines arrowed indicating their approximated distance apart.

(b) How would you account for the fact that a carious lesion just reaching the enamel–dentine junction in a tooth which has just erupted into the mouth is likely to be associated with a pulpal response, whilst such a lesion in the tooth of an aged individual will often be without a pulpal response?

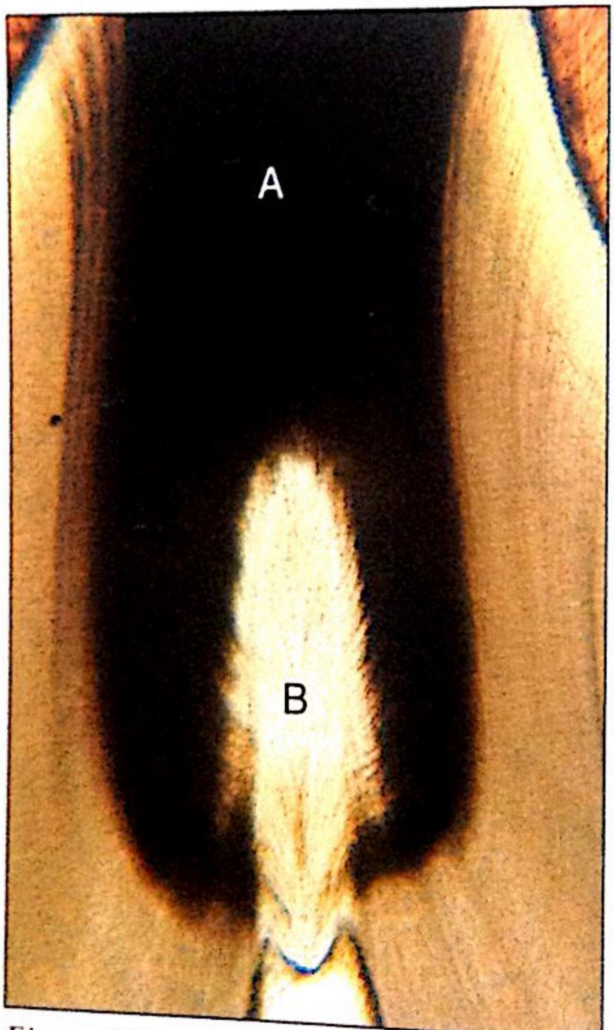


Figure 75

85 This is a micrograph of a section of a tooth mounted in Canada balsam *(Figure 75)*.

(a) Is this a ground or a demineralised section?

(b) Identify zone A; account for its appearance.

(c) Identify zone B.

(d) What might you expect to see on the occlusal surface of this tooth?

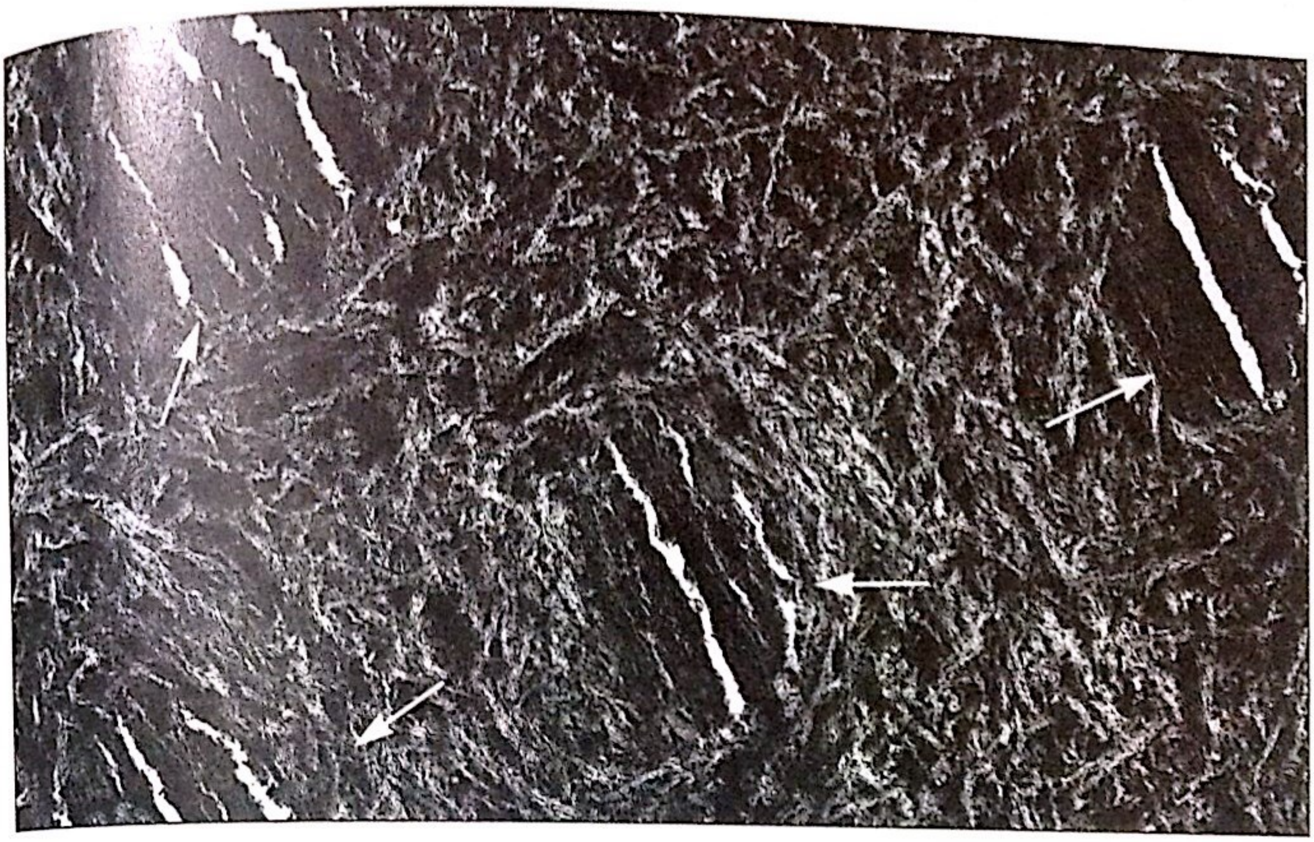


Figure 76

86 This is an electronmicrograph of a cross-section of dentine bordering a carious lesion *(Figure 76)*. Explain what it demonstrates.

87 What is happening in the pulp shown in the picture below? *(Figure 77)*

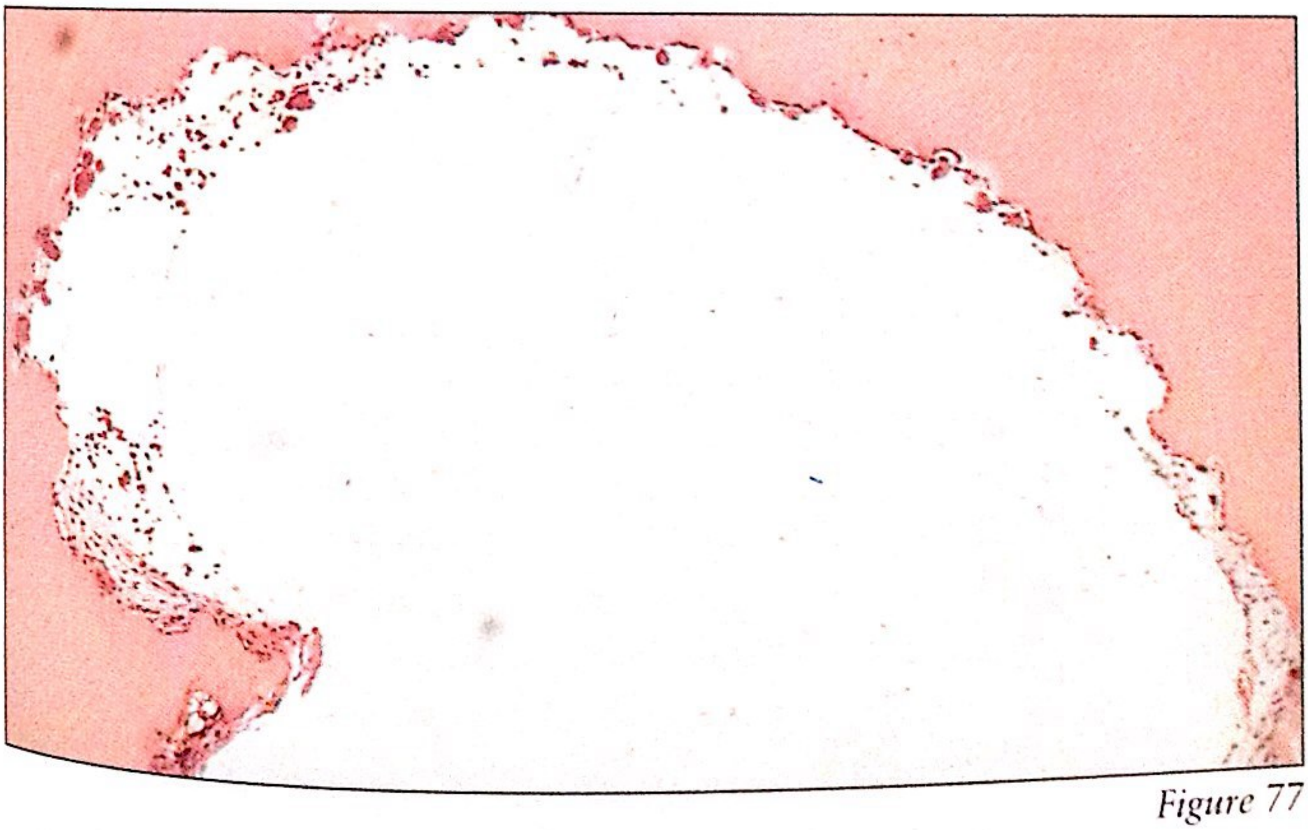


Figure 77

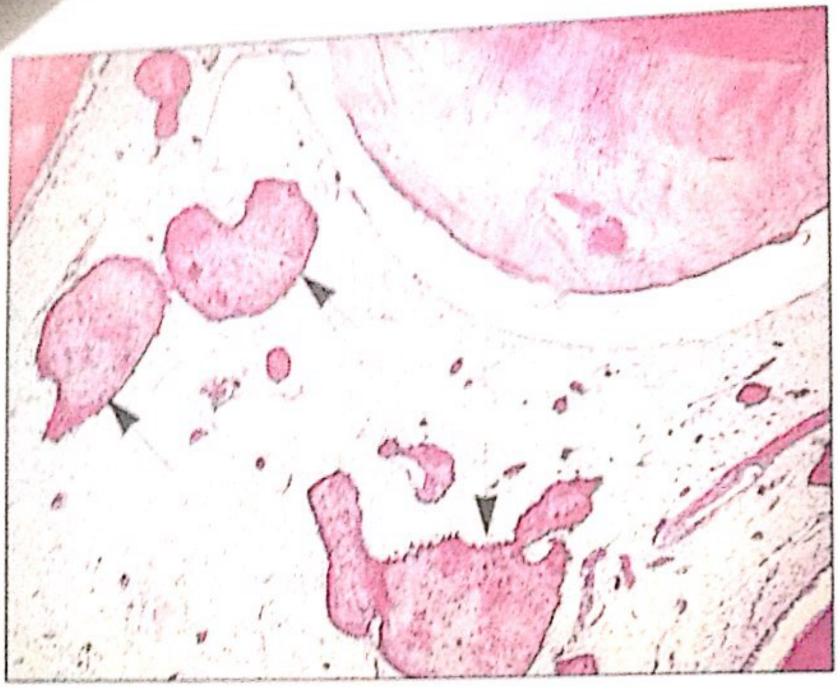


Figure 78

88 This is a longitudinal section of the pulp (*Figure 78*).

(a) Is this a ground or a demineralised section?

(b) Identify the structures in the pulp that are arrowed.

(c) How would you classify such structures?

(d) Would you expect to see the structures that are arrowed on radiographs, and can they produce any symptoms?

89 This is a demineralised section of a tooth (*Figure 79*). Identify this type of dentine, including zones A, B and C.

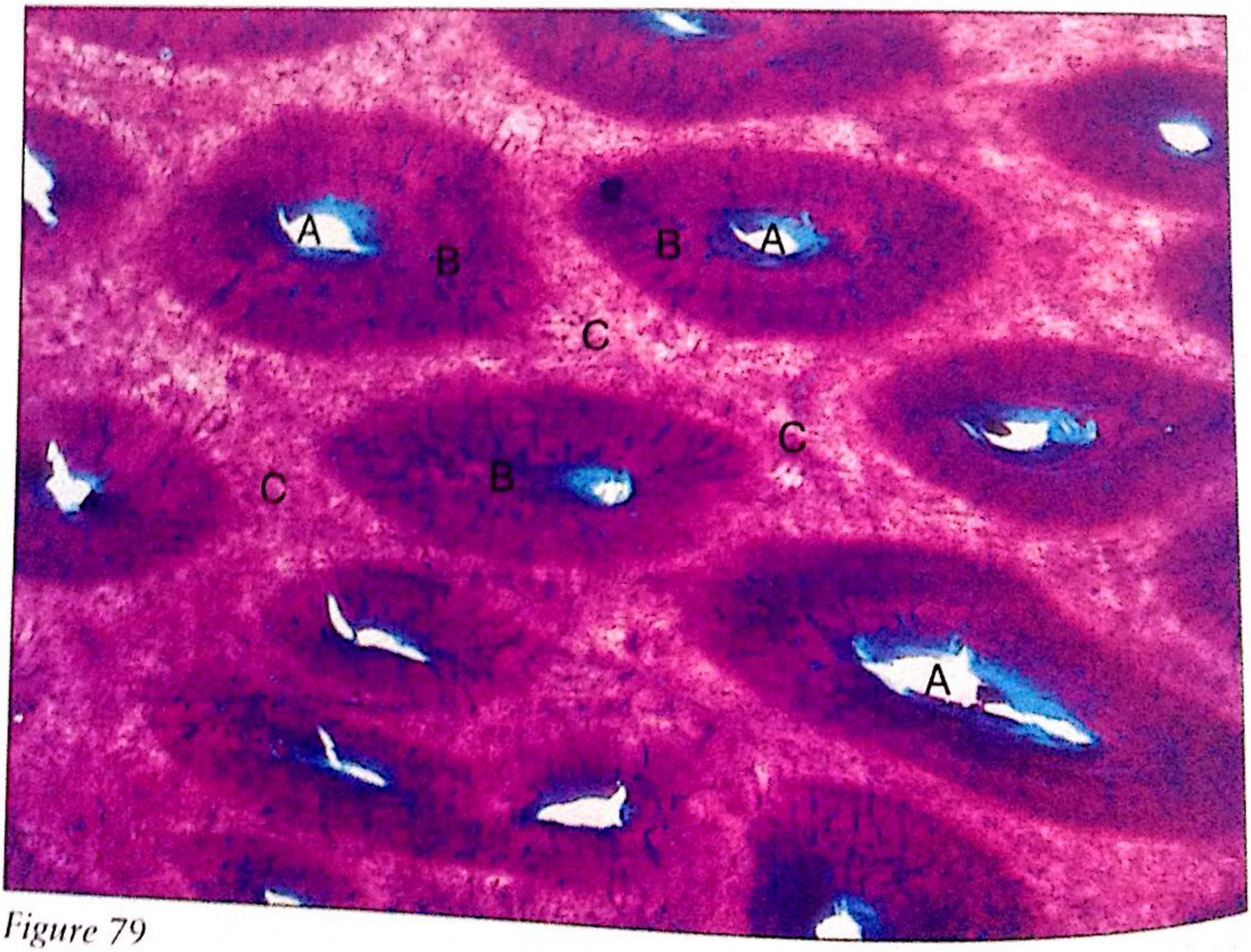


Figure 79

Cementum and Alveolar Bone

90 Which of the following statements are true:

(a) Cementum consists of 65% mineral, 25% organic matrix and 12% water on a volume basis.

(b) Cementoblasts are derived from the epithelial root sheath (of Herwig).

(c) The incremental lines in cellular cementum are further apart than those in acellular cementum.

(d) Cervical enamel may be covered by a type of cementum lacking any collagen fibres (afibrillar cementum).

(e) The formation of cementum ceases following removal of the pulp.

(f) The uncalcified matrix of cementum is termed intermediate cementum.

(g) Sharpey fibres in cementum have a similar diameter to those in alveolar bone.

(h) Like the adjacent periodontal ligament, cementum contains about 20% type III collagen.

(i) Acellular and cellular cementum can be distinguished using polarised light microscopy.

(j) The canaliculi in cementum and bone show no preferential orientation.

(k) Bundle bone refers to the alveolar bone into which Sharpey fibres are embedded.

(l) In the incisor region, little cancellous bone is present between inner and outer cortical plates of alveolar bone.

(m) In the alveolar crest region, Sharpey fibres may extend completely through the alveolar bone (transalveolar fibres).

(n) A histochemical marker for osteoblasts is alkaline phosphatase.

(o) The receptors for parathormone (which leads to bone resorption) are found on osteoblasts.

(p) Cancellous bone of the alveolus is haemopoietic during childhood.

(q) Osteoclasts; like periodontal fibroblasts, degrade collagen in intracellular collagen profiles.

(r) Mesial drift of a molar tooth is accompanied by osteoblasis distally and osteoclasis medially.

(s) The basic unit of bone, the lamella, is about 5μm thick.

(t) In cancellous bone, the trabeculae are about 500μm thick.

Figure 80

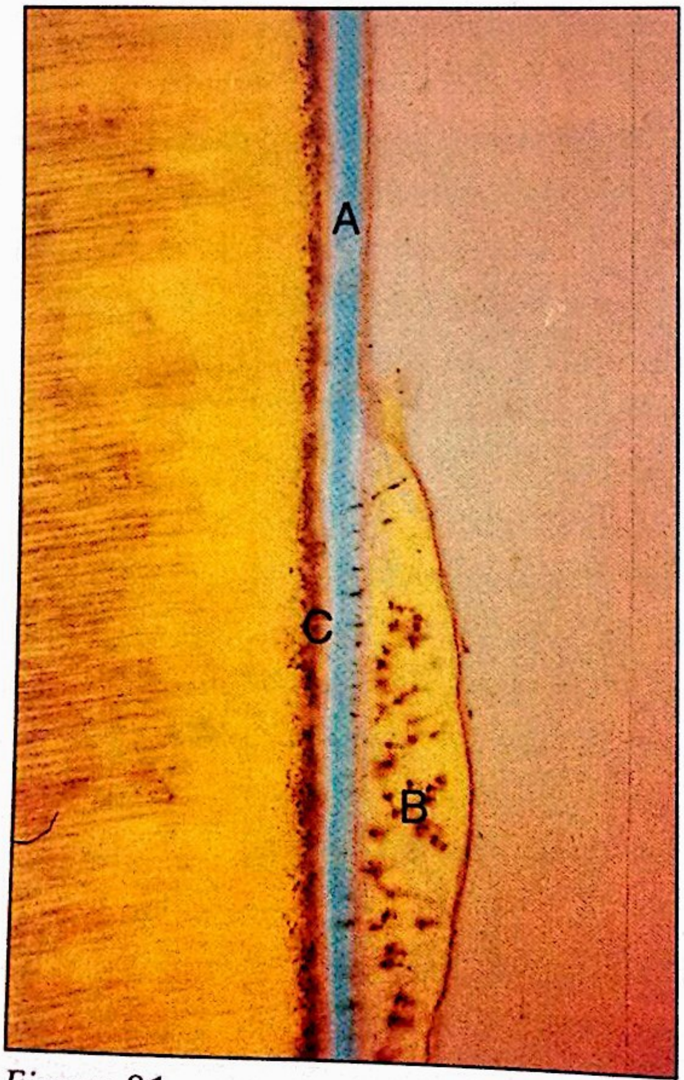


Figure 81

91 *(Figure 80)*

(a) Identify A to C.

(b) Is this the typical arrangement of the tissues?

(c) List four differences between tissues A and B.

(d) Classify tissues A and B based on the nature and origin of the organic matrix.

(e) Describe the histological appearance of reparative cement.

92 This is a ground longitudinal section of a tooth viewed in polarised light *(Figure 81)*.

(a) Identify the tissues labelled A, B and C.

(b) Account for the colour difference between tissues A and B.

(c) Is the direction of the root apex beyond the top or the bottom of the micrograph?

93 *(Figure 82)*
(a) Identify A to E.
(b) Is the process illustrated here common in permanent teeth?

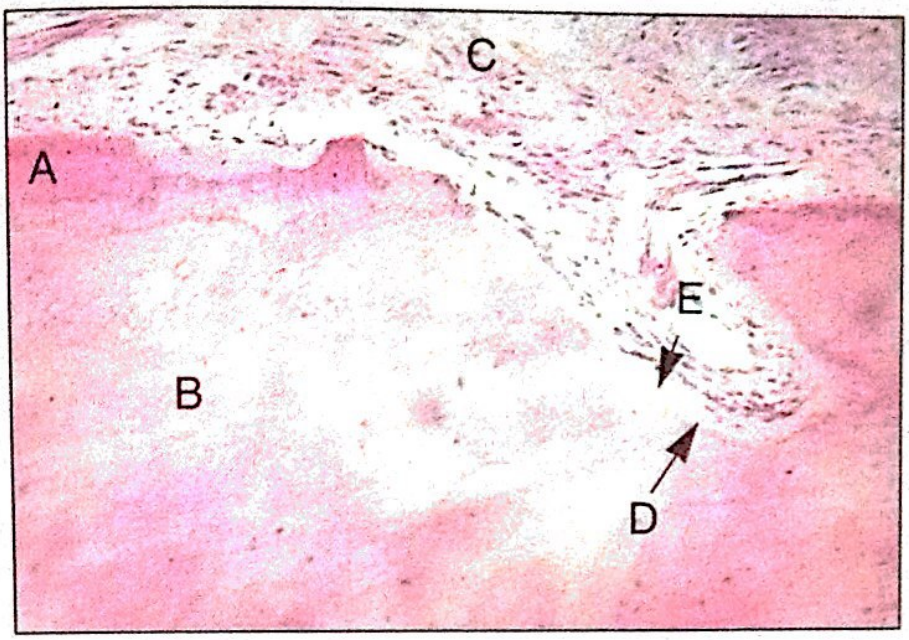


Figure 82

94 *(Figure 83)*
(a) Is this a ground or demineralised section?
(b) Identify cell types A, B, C.
(c) Do cell types A and B have the same origin?
(d) Are there any connections between cells labelled C?
(e) Account for the staining difference between the paler zone immediately adjacent to cell layer B and the rest of the matrix D.

Figure 83

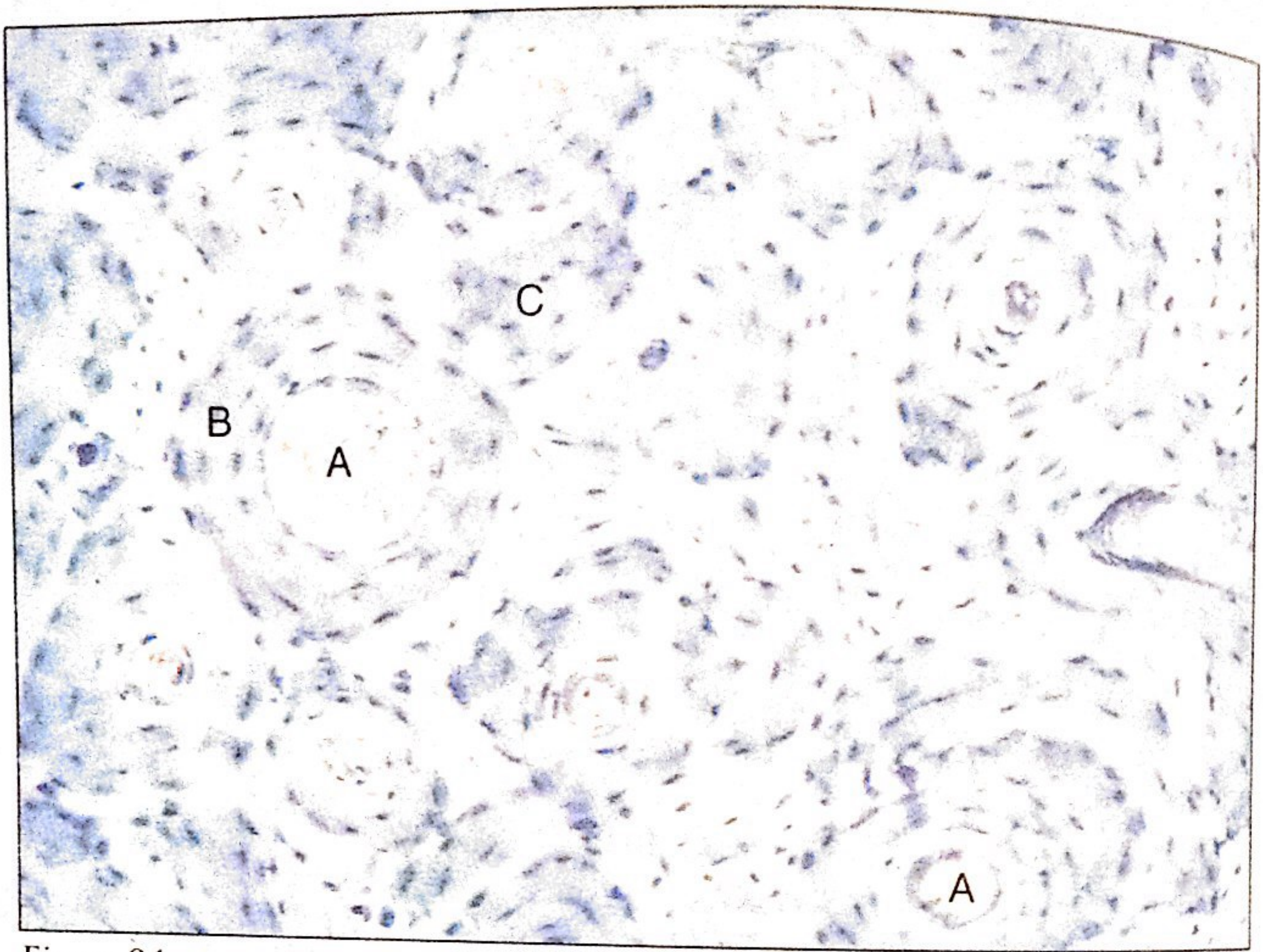


Figure 84

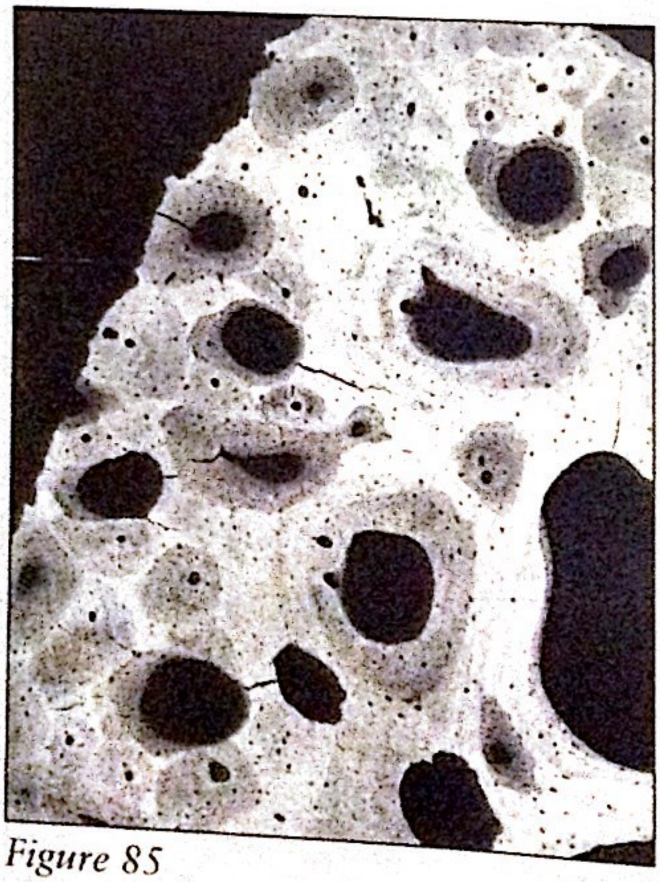


Figure 85

95 This is a ground section (*Figure 84*).
(a) Identify the structures labelled A, B and C.
(b) What occupies the numerous small black areas (arrowed)?
(c) What volume of the tissue is occupied by the organic matrix?

96 This is a ground section (*Figure 85*).
(a) What technique is illustrated here?
(b) Account for the variation in shades of white and grey.

97 *(Figure 86)*
(a) This is a scanning electron-micrograph of the surface of alveolar bone adjacent to the root of a tooth. The organic surface layer has been removed with hypochlorite. Account for the difference seen between the upper and lower parts of the micrograph.
(b) Identify the structures arrowed.

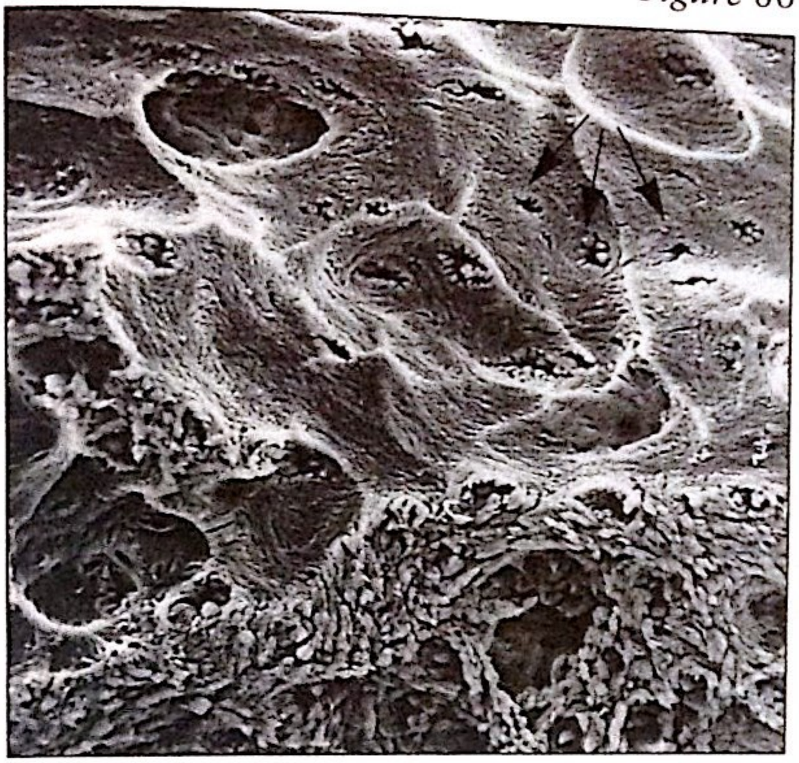


Figure 86

98 *Figure 88* is a ground section of the region arrowed in *Figure 87*.
(a) Name the condition given to account for the appearance of the increased thickness of layer A in this micrograph.
(b) What might one often find associated with the incisal edge of a tooth with the appearance seen in *Figure 88*?
(c) What local pathological condition may be responsible for producing the increase in thickness of layer A?
(d) Name the rare condition which may produce a generalised increase in the thickness of layer A in all the teeth.
(e) What clinical problems may arise as a result of this condition?


Figure 87

Figure 88

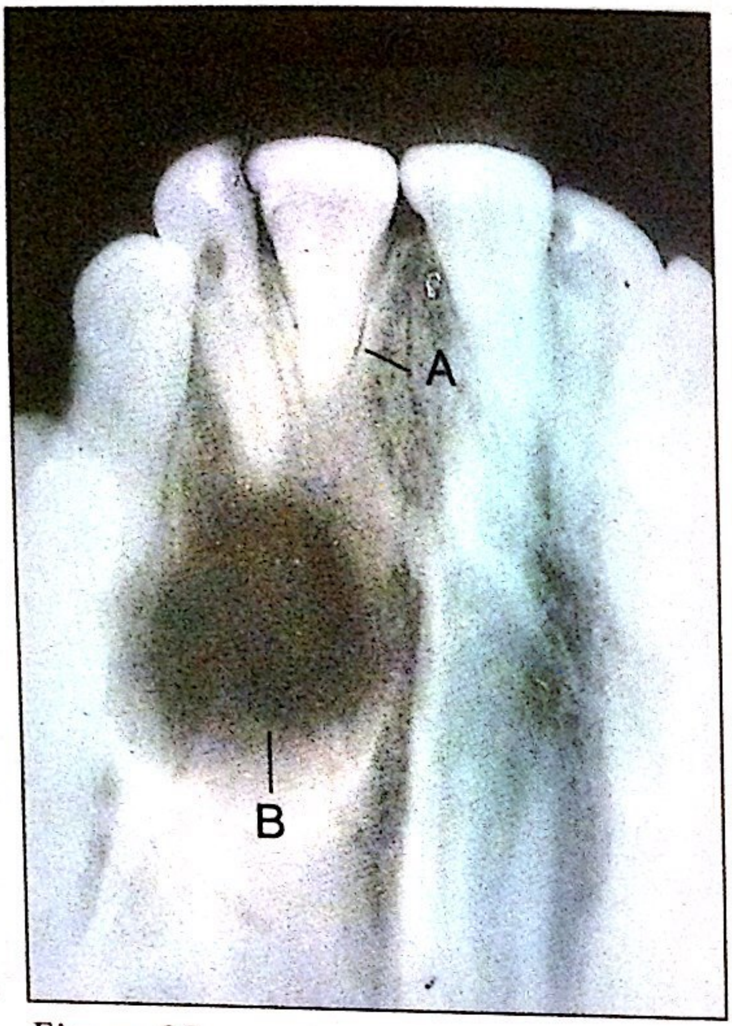


Figure 89

99 *(Figure 89)*

(a) Name feature A.

(b) Account for its radiological appearance.

(c) Is the appearance in the region of the alveolar crest similar throughout the jaw?

(d) What feature determines whether the radiolucency at the root apex B is pathological?

(e) What would be the principal radiological feature associated with chronic periodontal disease?

(f) Could a fracture of a root be diagnosed on a radiograph?

(g) When would the first radiographic signs of bony repair be evident in the socket of an extracted tooth?

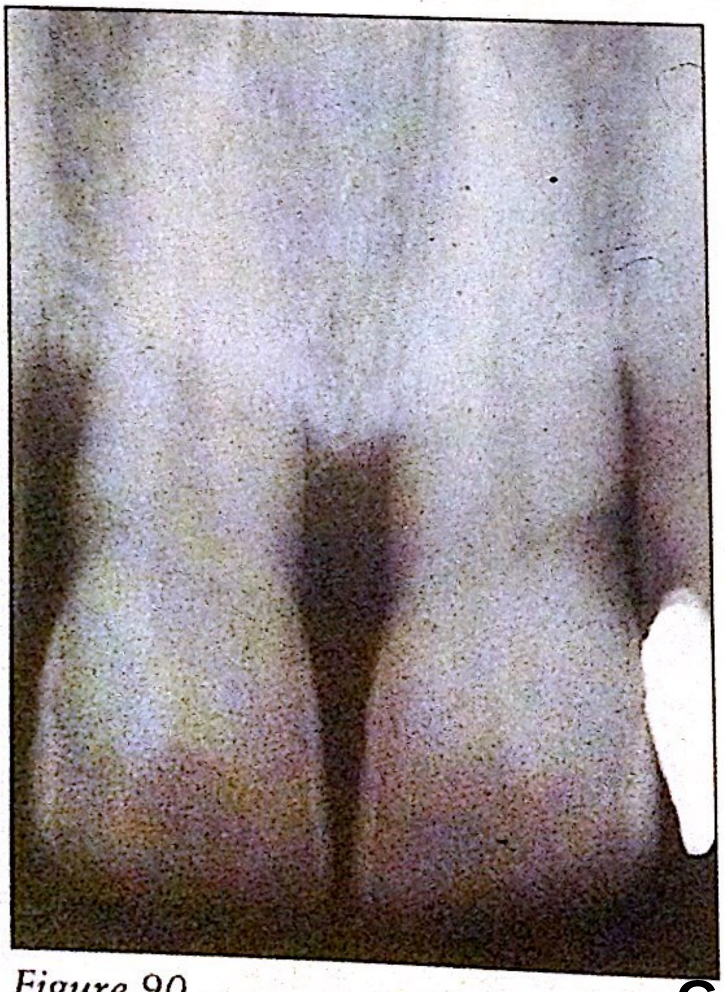


Figure 90

100 This is a radiograph of the maxillary permanent central incisors *(Figure 90)*.

(a) Does this represent a healthy or diseased state, and why?

(b) Is the increase of mobility of the periodontically affected tooth directly related to the amount of alveolar bone loss?

Periodontal Ligament

101 Which of the following statements are true:

(a) The normal width of the periodontal space is 0.8mm.

(b) The collagen in the periodontal ligament is arranged as 'principal fibres', the most common of which are termed the oblique fibres.

(c) Within the collagen fibres are collagen fibrils; these are small in diameter for the periodontal ligament and suggest a connective tissue placed under tension.

(d) All the periodontal collagen fibres are attached to the alveolar bone as Sharpey fibres.

(e) The Sharpey fibres from the bone often project into the periodontal ligament as calcified stubs, a feature of a connective tissue under tension.

(f) The collagen fibres are organised as distinct tooth-related and bone-related fibres.

(g) Oxytalan fibres can be readily observed in the periodontal ligament using haematoxylin and eosin stains.

(h) Oxytalan fibres are said to increase in number under increased loading of the tooth.

(i) The periodontal ligament is rich in ground substance.

(j) The fibroblasts of the periodontal ligament are myofibroblast-like, containing distinct bundles of microfilaments.

(k) 'Collagen profiles' within the periodontal fibroblasts suggest that collagen degradation occurs intracellularly.

(l) As for fibroblasts in all other connective tissues, the periodontal fibroblasts are 'linked' by numerous intercellular junctional organelles.

(m) The cementoblasts lining the dental cement are derived from circulating monocytes.

(n) The 'rests of Malassez' are the remains of the developmental epithelial root sheath.

(o) The blood supply to the periodontal ligament is derived entirely from the apical vessels passing into the dental pulp.

(p) The periodontal ligament is unusual in that it has numerous fenestrated capillaries.

(q) The periodontal ligament is richly innervated with sensory and autonomic nerves.

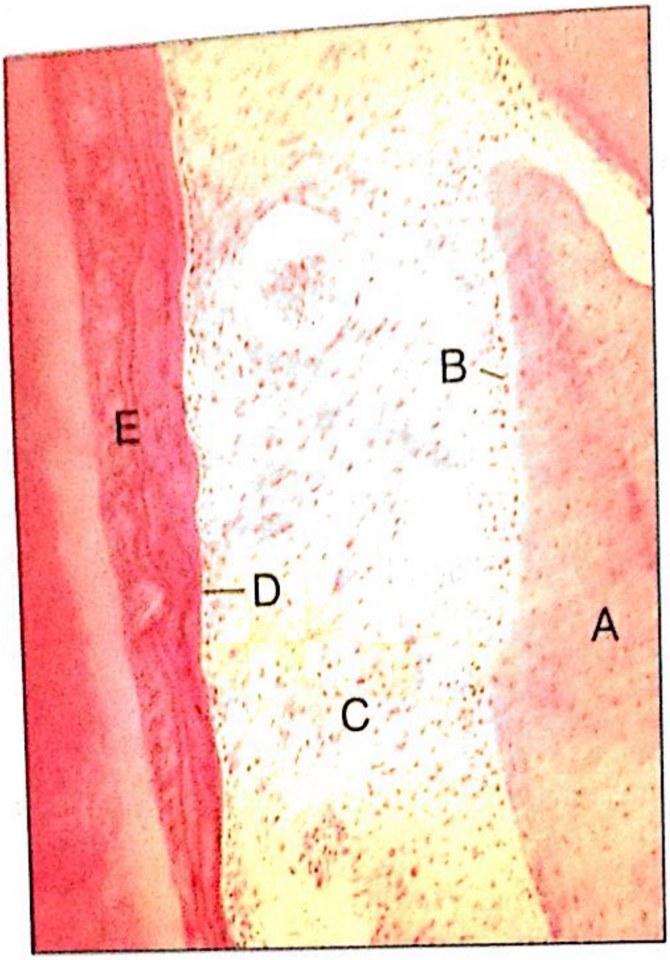


Figure 91

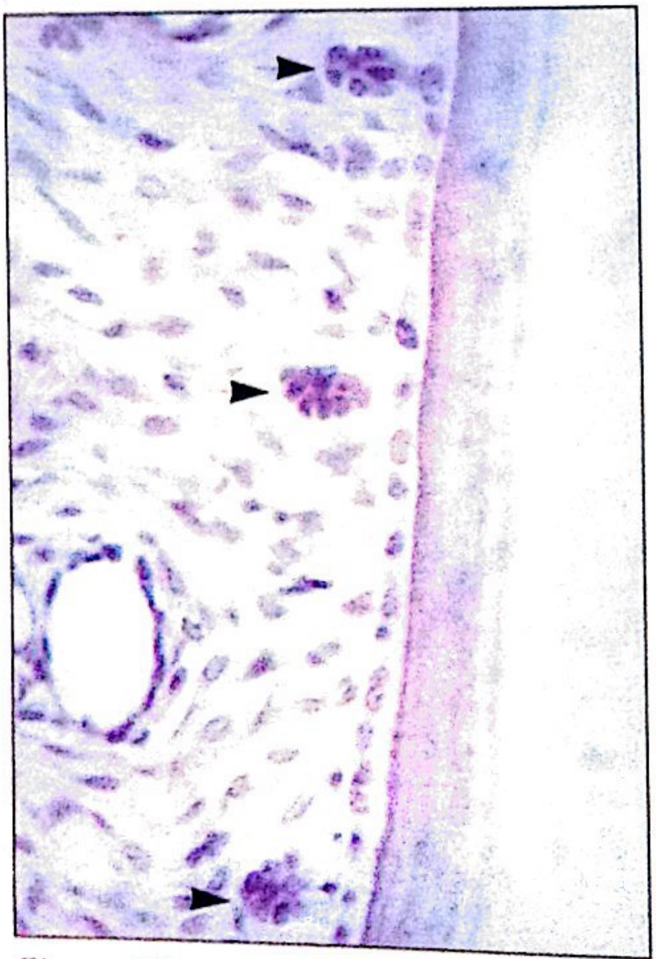


Figure 92

(r) Specialised, encapsulated mechanoreceptors are frequently found in the periodontal ligament.
(s) Comparisons of the periodontal ligament with other fibrous connective tissues indicate that it is mainly placed in tension during loading.
(t) The high rate of turnover of the periodontal ligament is one of its foetal-like (mesenchymal) features.

102 *(Figure 91)*
(a) Identify the various components of the periodontal ligament labelled A to E.
(b) What factors influence the width of the periodontal space?
(c) Name the various types of the fibres found in the periodontal ligament.
(d) What non-connective tissue cells may be present in the periodontal ligament?
(e) In which direction is this tooth moving?

103 This is a section of the periodontal ligament *(Figure 92)*.
(a) Name the cells indicated by arrows.
(b) In relation to the adjacent tissues, what is their most unique feature?
(c) What is their clinical significance?

104 What does this electronmicrograph showing the structure of a periodontal fibroblast tell you about its function? *(Figure 93)*

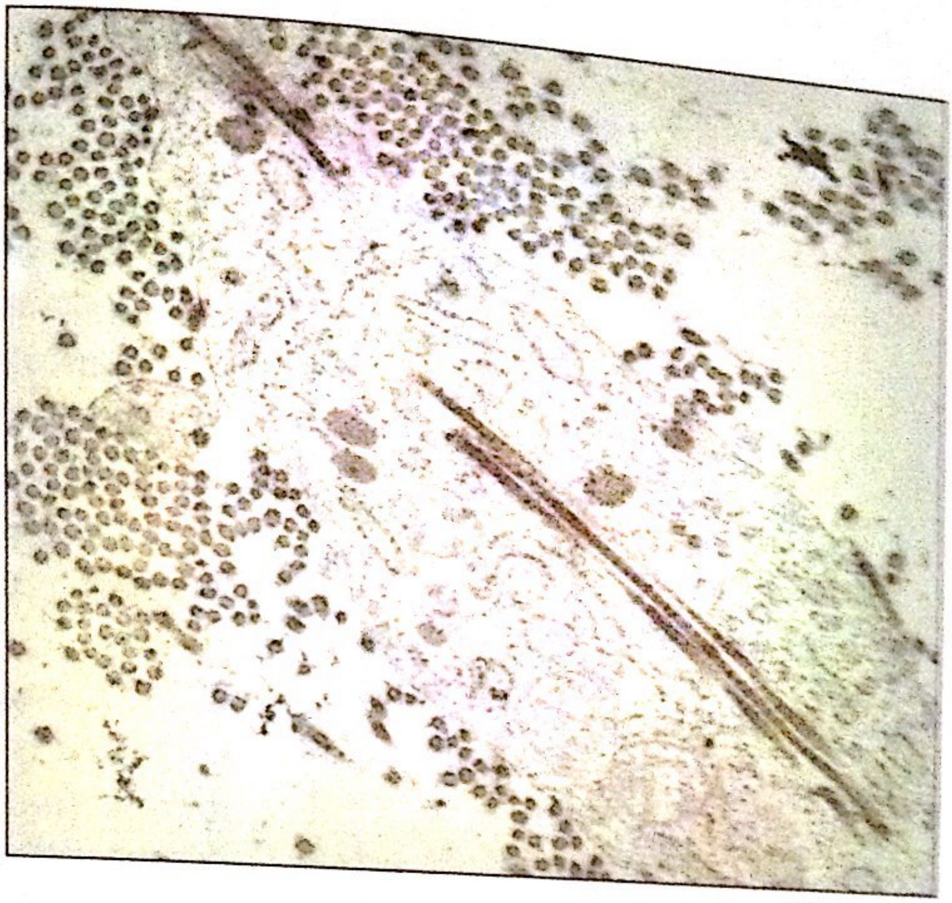


Figure 93

105 This is a longitudinal section of a tooth *(Figure 94)*.

(a) Identify the principal features seen at A and B, indicating their composition.

(b) Do these structures have a rapid or slow turnover?

(c) Why are no cells evident in these regions?

(d) Identify C and D.

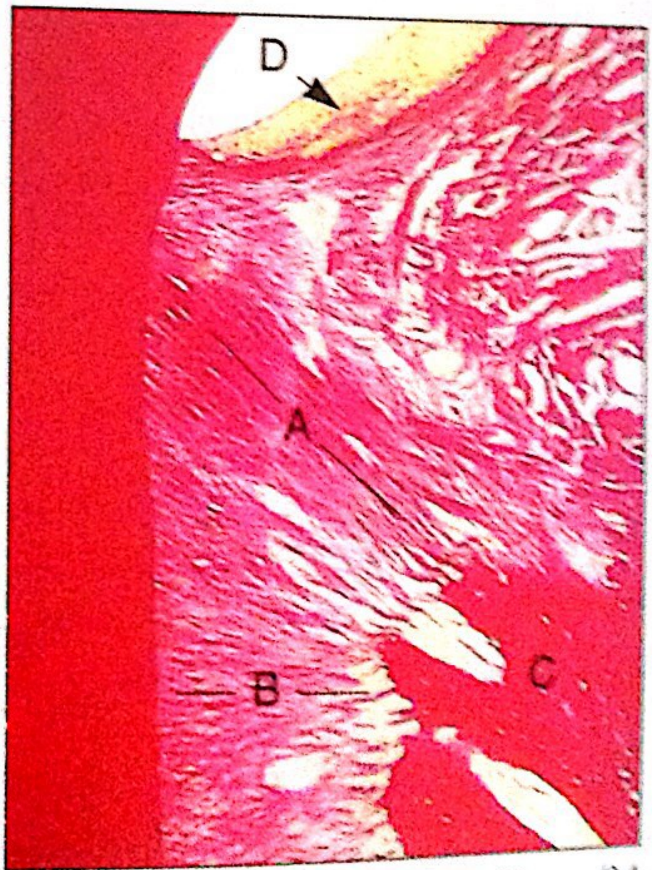


Figure 94

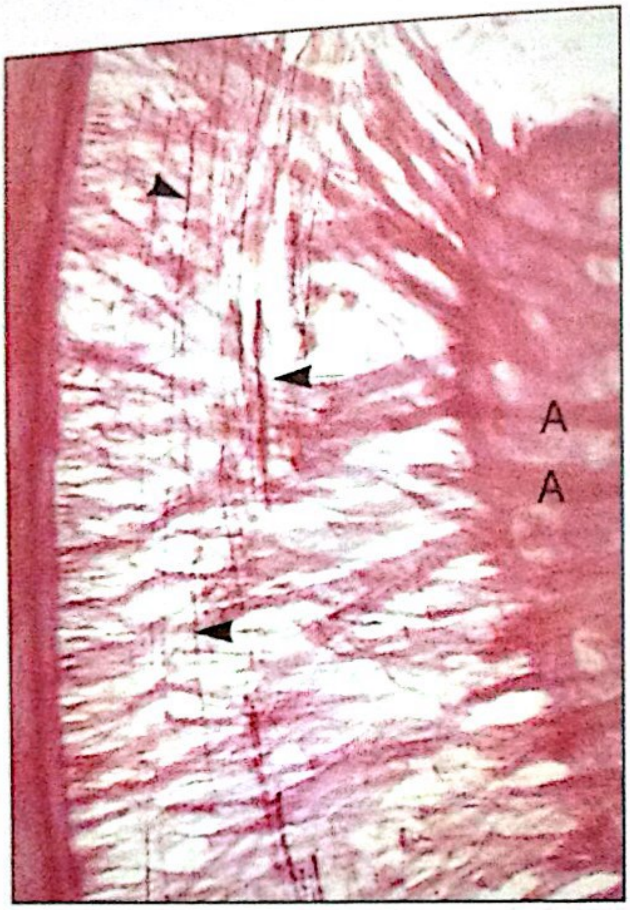


Figure 95

106 This is a longitudinal section of a tooth near the alveolar crest (*Figure 95*).

(a) Identify the vertically oriented lines arrowed.

(b) Describe their ultrastructural appearance.

(c) What volume of the periodontal ligament do they occupy?

(d) Identify the horizontal lines labelled A, indicating their extent.

107 (*Figure 96*)

(a) What is the cell type shown in this electronmicrograph?

(b) Identify the features labelled A to C.

(c) What is the function of this cell?

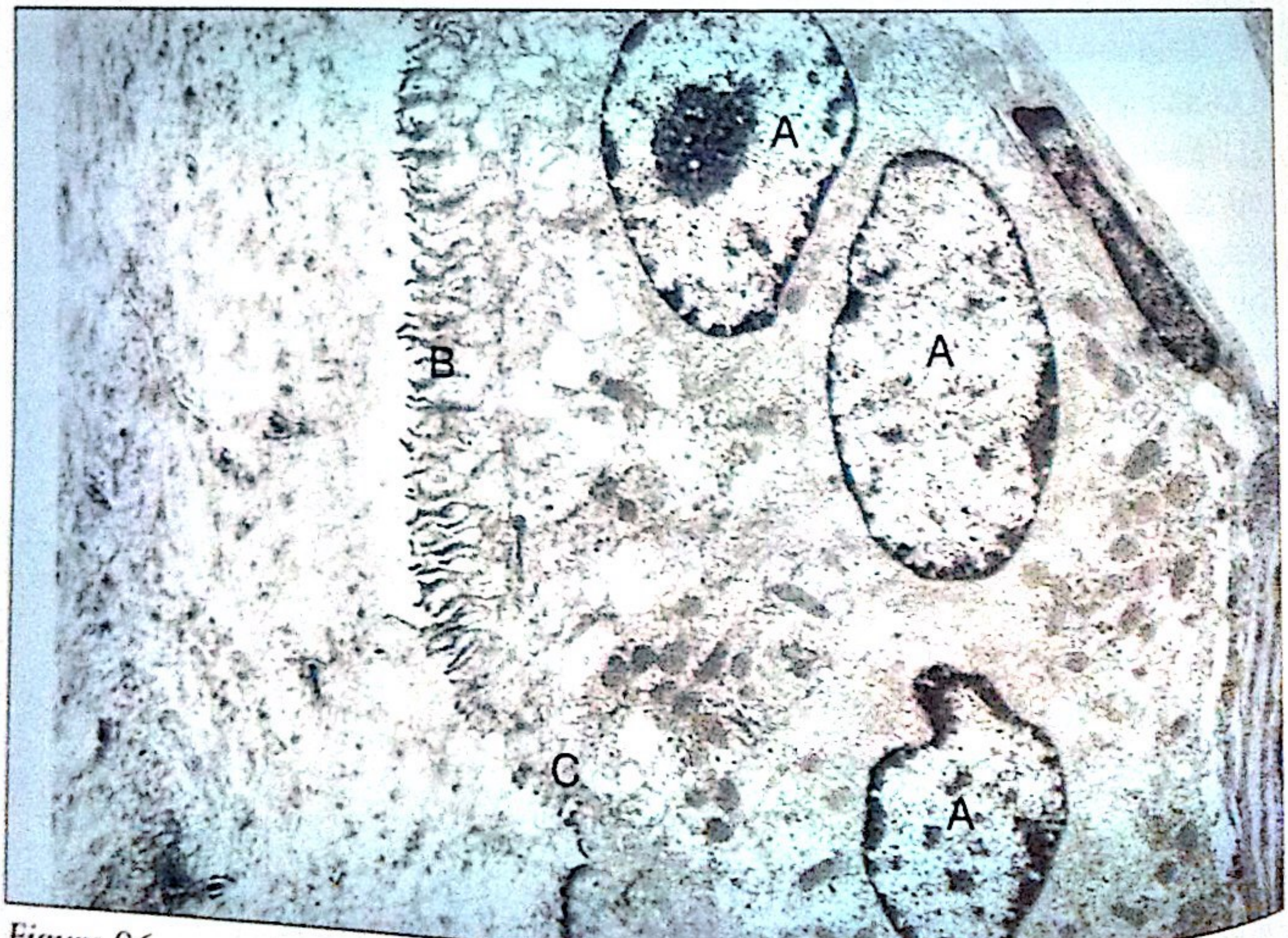


Figure 96

108 *(Figure 97)*
(a) Identify the features of the periodontal ligament labelled A to E.
(b) What features of the periodontal vasculature may be considered unusual/specialised compared with the vasculature of a typical fibrous connective tissue?
(c) What is the evidence for and against the notion that there is an intermediate plexus/zone of shear towards the middle of the periodontal ligament?

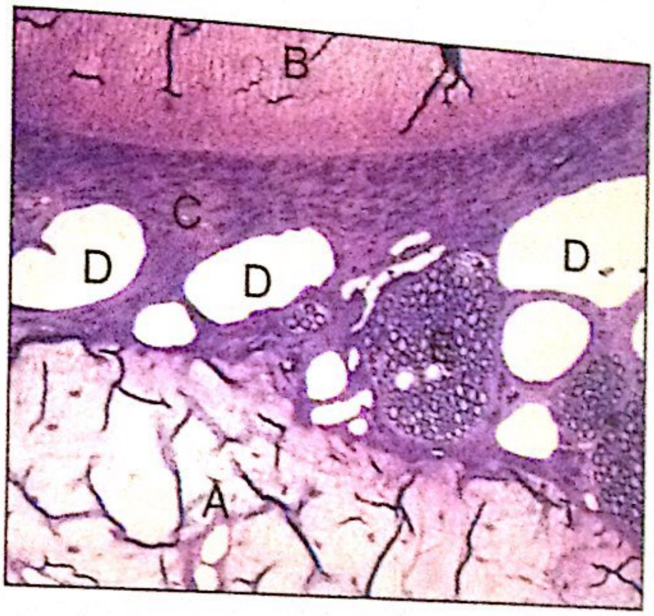


Figure 97

109 Scientists have sought an analogue for the periodontal ligament by comparing the tissue with other connective tissues elsewhere in the body. Why is this an important and useful thing to do? What has been the result of such comparisons?

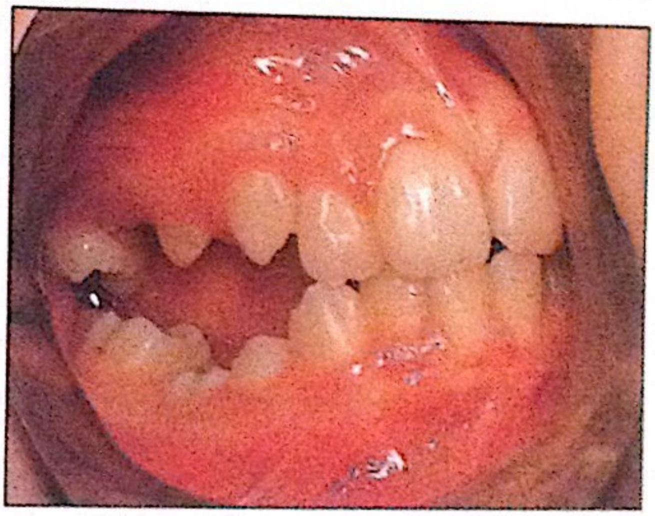


Figure 98

110 Comment on the abnormality seen in the mandibular dentition of this 12-year-old child. *(Figures 98 and 99)*

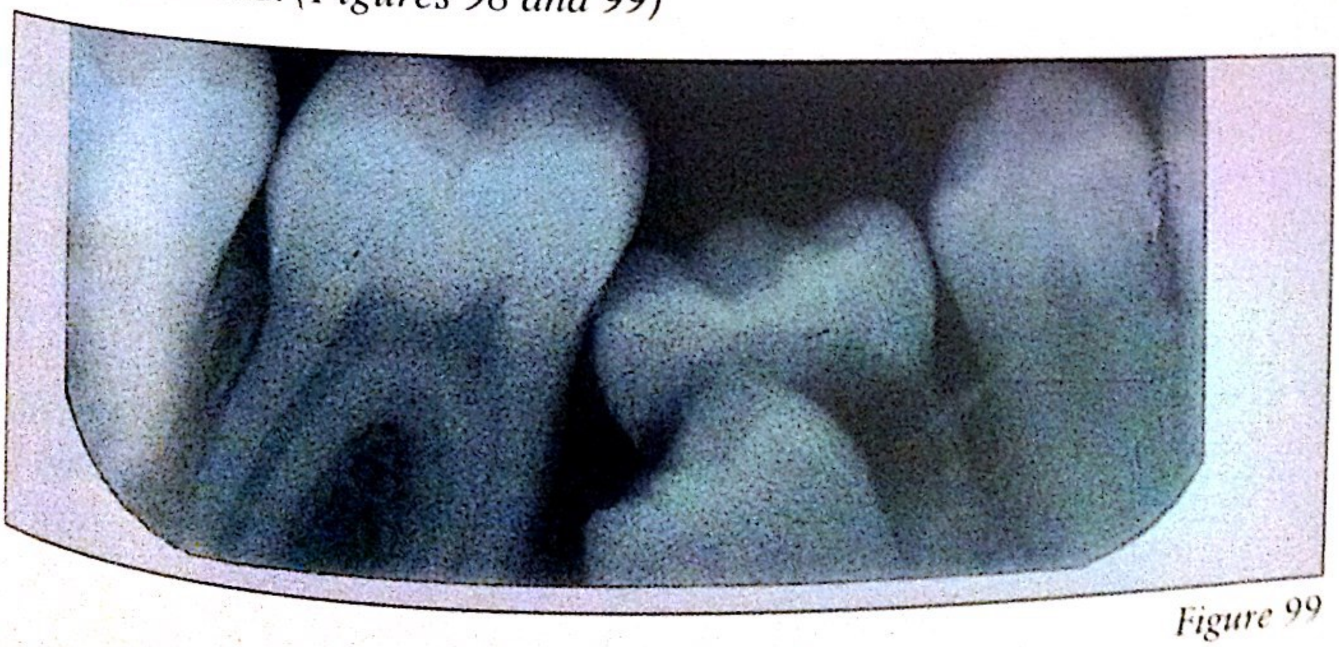


Figure 99

Oral Mucosa

111 Which of the following statements are true:

(a) Cells of the stratum corneum have a thin, resistant layer comprised of involucrin just beneath the plasma membrane.

(b) Parakeratosis refers to the incomplete loss of nuclei during keratinisation.

(c) Approximately 10% of cells in the oral epithelium are non-keratinocytes.

(d) Langerhans cells, like melanocytes, are derived from ectomesenchyme (neural crest) cells.

(e) The gingiva forms a characteristic interdental col between teeth which are spaced.

(f) The sulcular epithelium possesses a granular layer.

(g) The junctional epithelium is unique in having both an internal and an external basal lamina.

(h) The junctional epithelium can completely regenerate following surgical removal.

(i) The attached gingiva presents a narrow submucosa.

(j) The alveolar mucosa has well-developed dermal papillae.

(k) Like skin, keratinised masticatory epithelium contains a stratum lucidum.

(l) Fungiform papillae on the anterior two-thirds of the tongue are keratinised.

(m) The vermilion (red) zone on the lip is keratinised, with pronounced dermal papillae.

(n) The lining epithelium on the tongue is derived embryologically from endoderm.

(o) Transseptal fibres pass from the cementum of adjacent teeth above the alveolar crest.

(p) There are at least 27 types of keratin.

(q) The free gingiva is stippled when healthy.

(r) The turnover time of masticatory epithelium is generally quicker than that for lining epithelium.

(s) Unlike the melanocyte, the Merkel cell exhibits some desmosomes.

(t) Being part of the same periodontium, turnover time for collagen in the gingiva is similar to that in the periodontal ligament.

112 *(Figure 100)*
(a) Identify this region of the oral cavity.
(b) Identify A to G.
(c) Classify A to D according to whether masticatory or lining mucosa.
(d) Which of the layers A to D has the highest turnover rate?
(e) List three important differences between C and D.

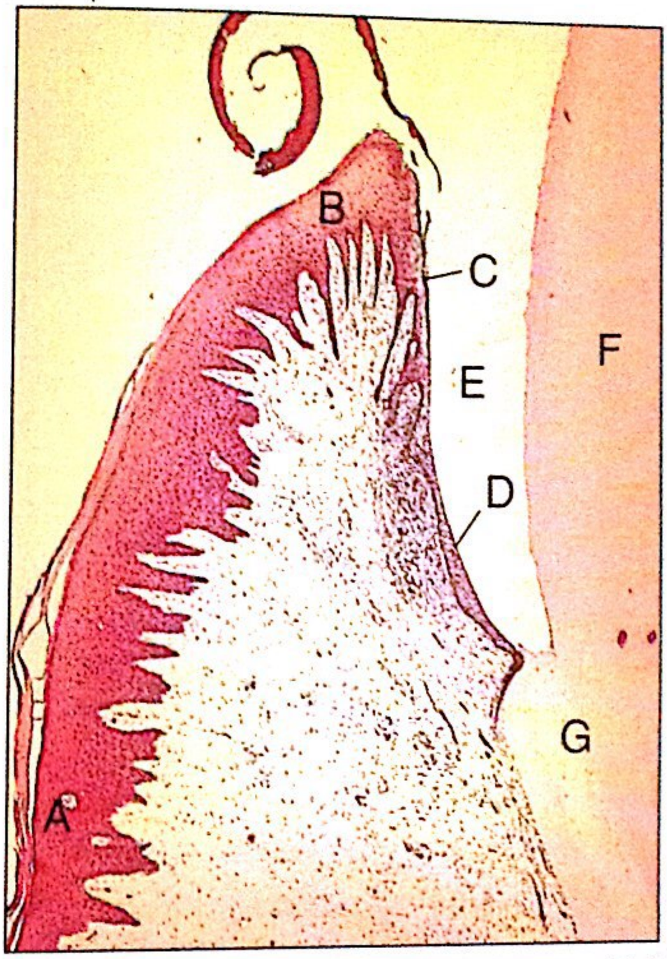


Figure 100

113 *(Figure 101)*
(a) Identify the region illustrated.
(b) Identify A to D.
(c) What glands are represented by E?

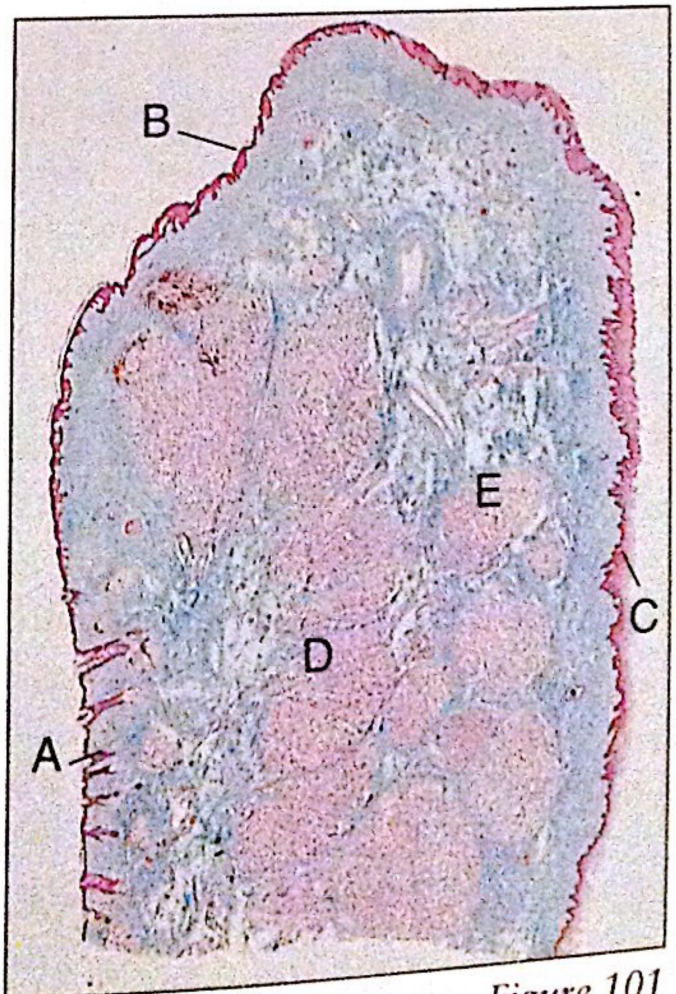
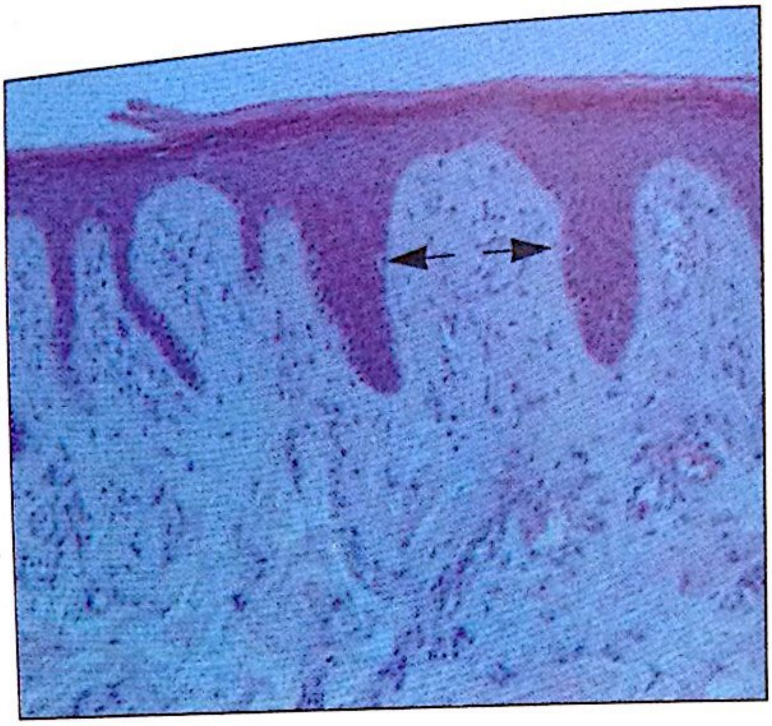


Figure 101



114 *(Figure 102)*

(a) Which of the zones A to C in *Figure 101* is represented by this micrograph?

(b) What is the significance of the clear cells arrowed?

Figure 102

115 *(Figure 103)*

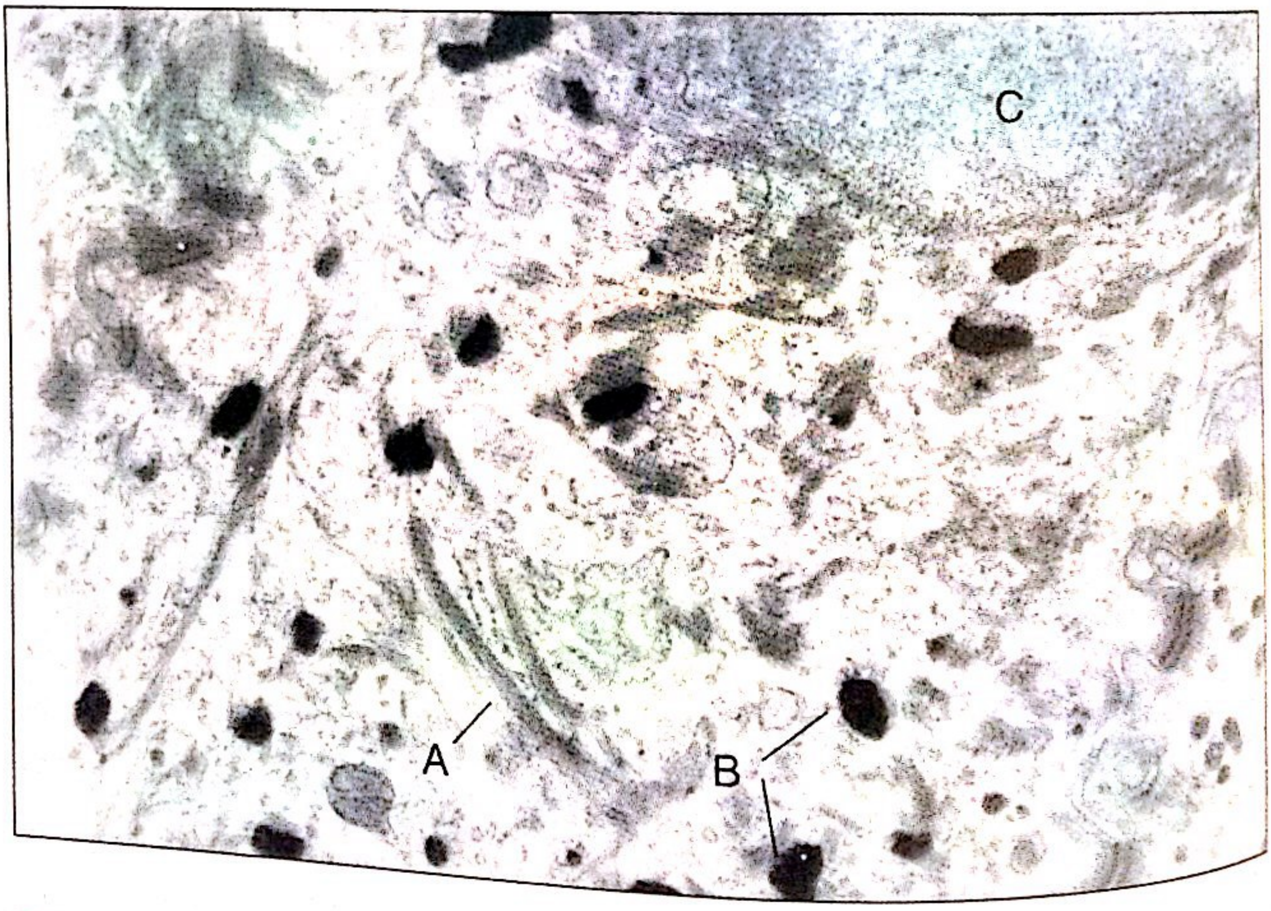
(a) Identify A to C in this keratinocyte from one of the layers of the oral epithelium.

(b) What layer does it come from?

(c) What does B contain?

(d) Does skin have similar cells?

Figure 103



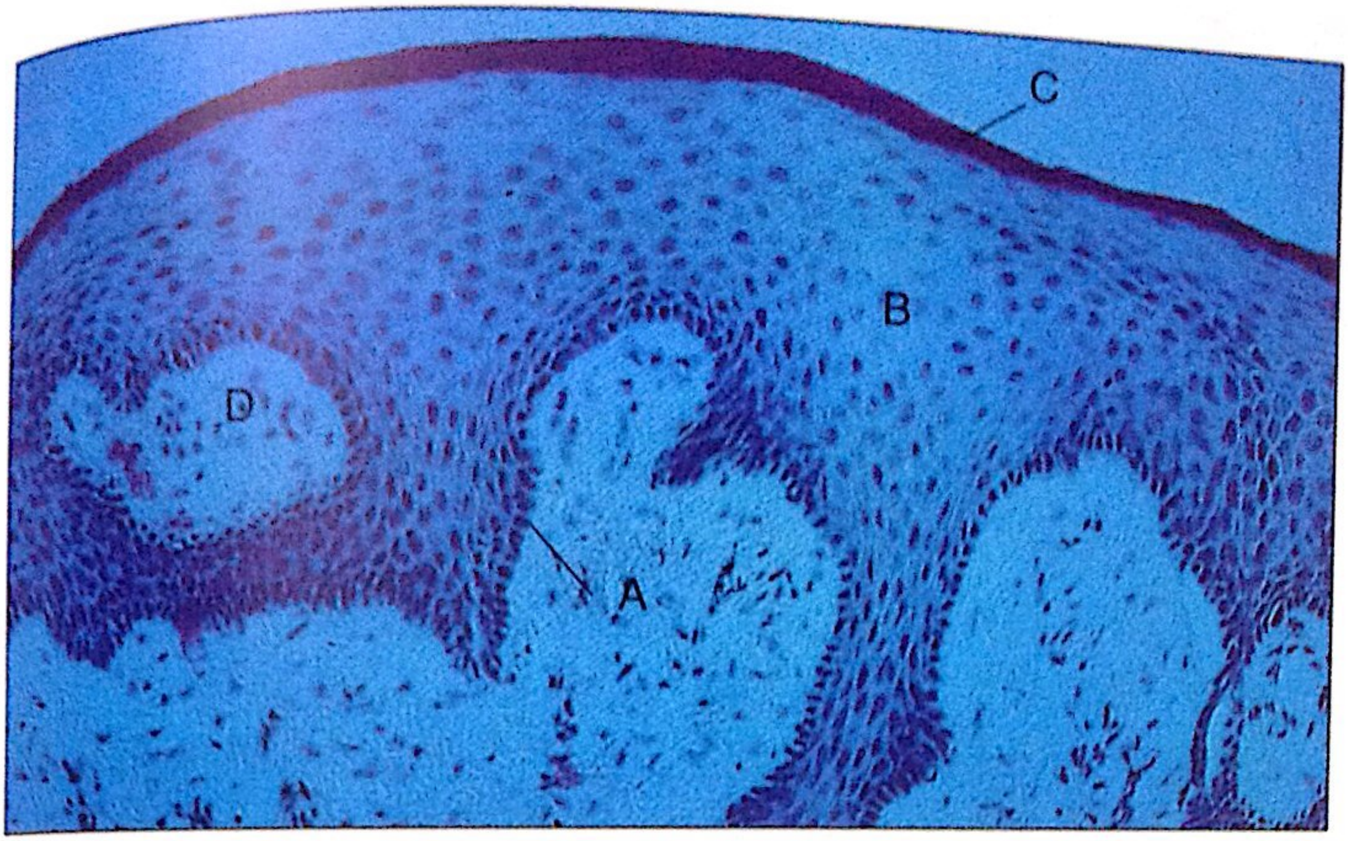


Figure 104

116 *(Figure 104)*
(a) Identify the layers labelled A, B and C.
(b) What region of the oral cavity may this represent?
(c) Account for the appearance of area D.
(d) What are the essential differences between the epithelium illustrated here and the epidermis in skin?

117 *(Figure 105)*
(a) What region of the oral cavity is illustrated in the micrograph and indicate your reasons?
(b) What type of epithelium is found on surfaces A and B?
(c) What type of tissue is C and what is its probable innervation?
(d) What is the innervation of D?

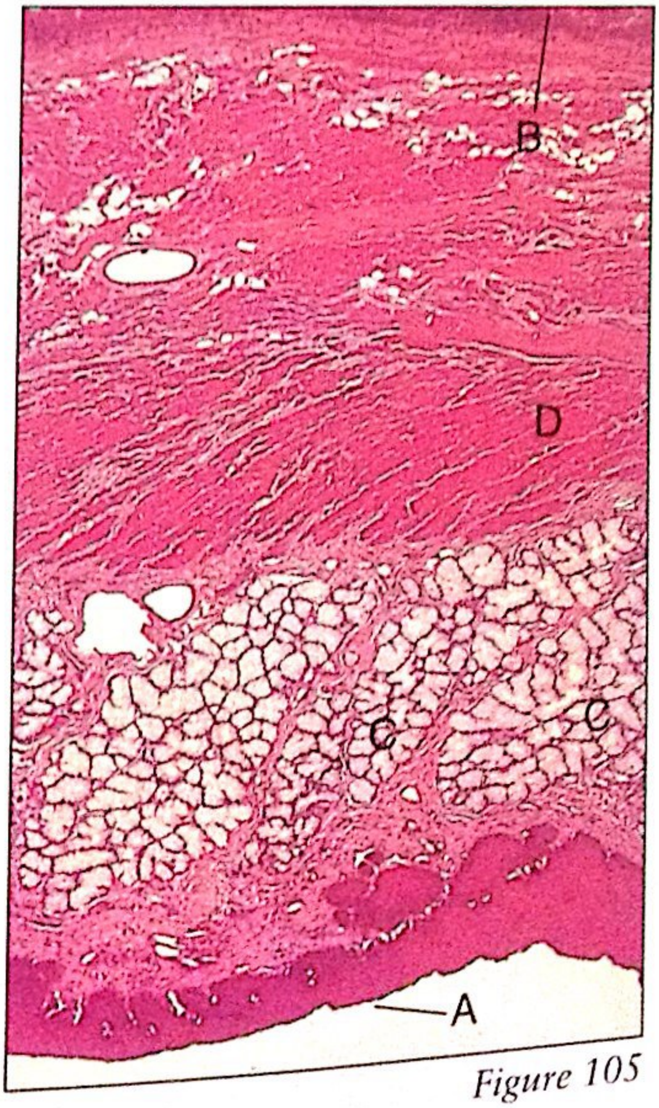
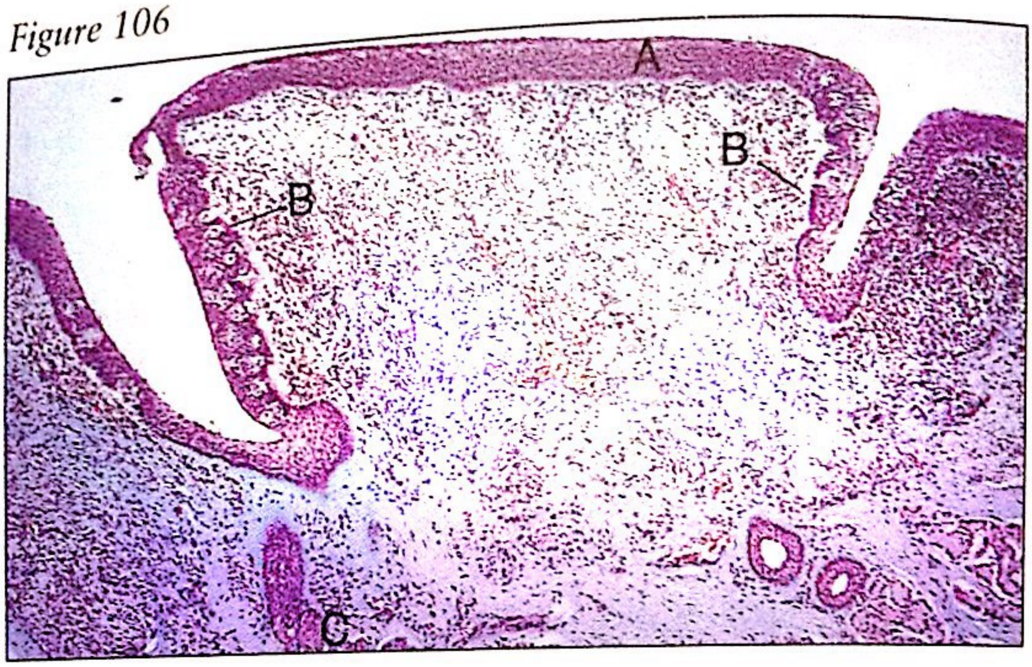


Figure 105

Figure 106



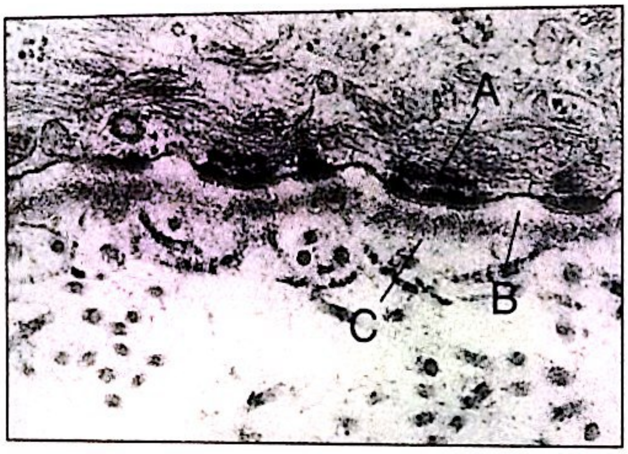


Figure 107

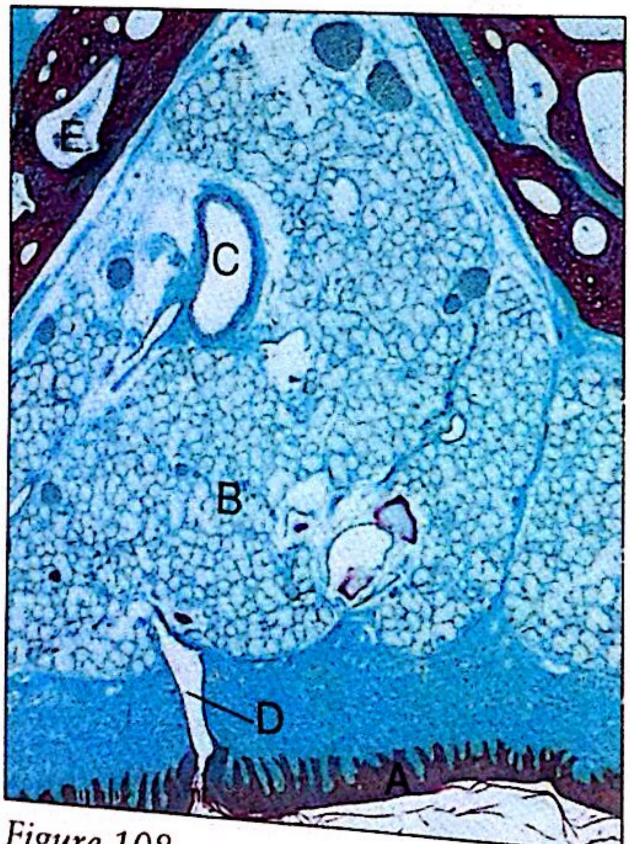


Figure 108

118 *(Figure 106)*

(a) Identify this structure.

(b) What type of epithelium occurs at A?

(c) Identify structure B, indicating its nerve supply.

(d) Identify C.

119 *(Figure 107)*

(a) Identify A to C.

(b) What is the principal component of B?

(c) What is the principal component of C?

(d) What cell produces B and C?

120 *(Figure 108)*

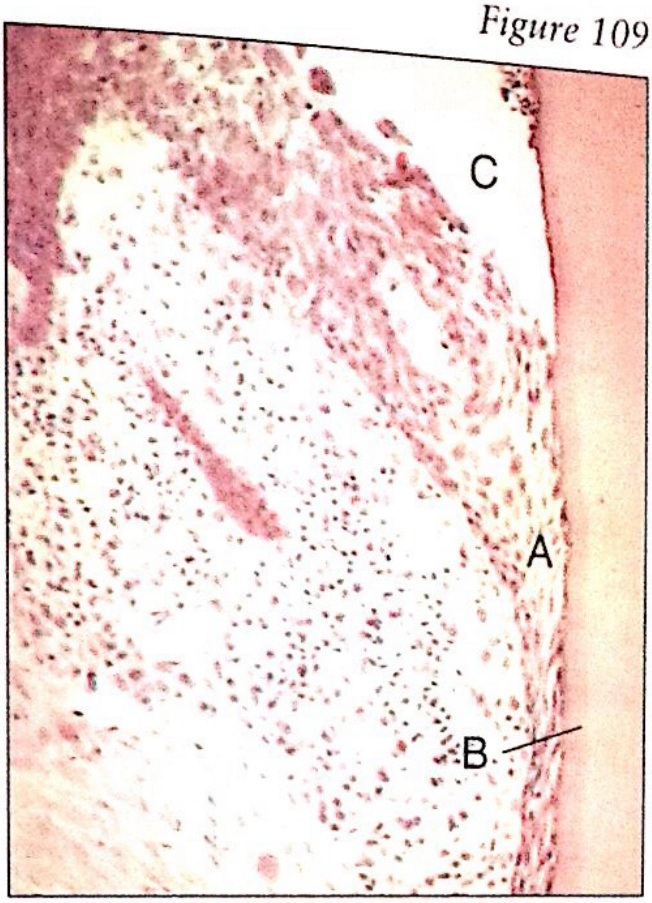
(a) Identify this region of the oral cavity.

(b) Classify the type of epithelium at A.

(c) Identify B to E.

(d) What is the innervation to B?

Figure 109



121 *(Figure 109)*
(a) Identify A to C.
(b) What is the means of attachment of A and B?
(c) Is this from a young or old patient?
(d) Is this normal, healthy tissue?

122 A patient has a long-term history of taking a drug called Epanutin to control his epilepsy. From the clinical and histological pictures presented, describe the results on the oral mucosa of taking the drug. *(Figures 110 and 111)*

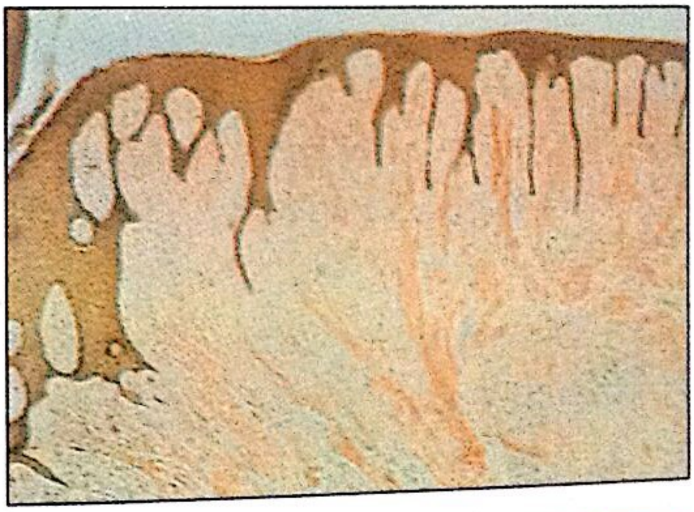


Figure 110

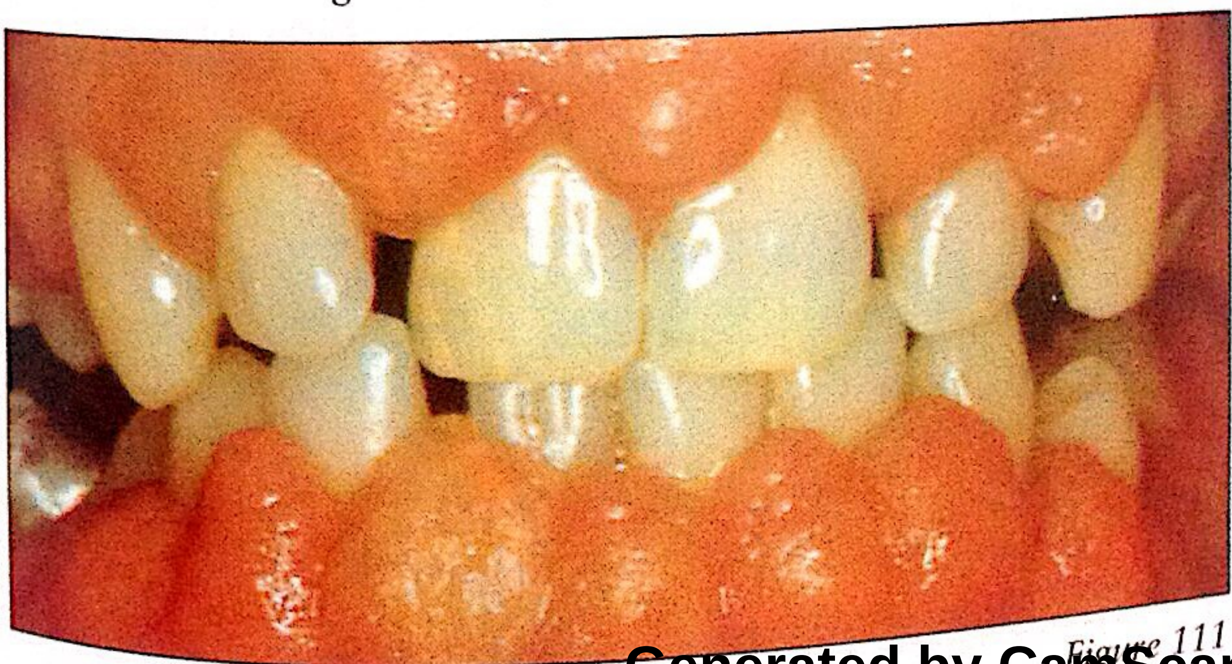


Figure 111

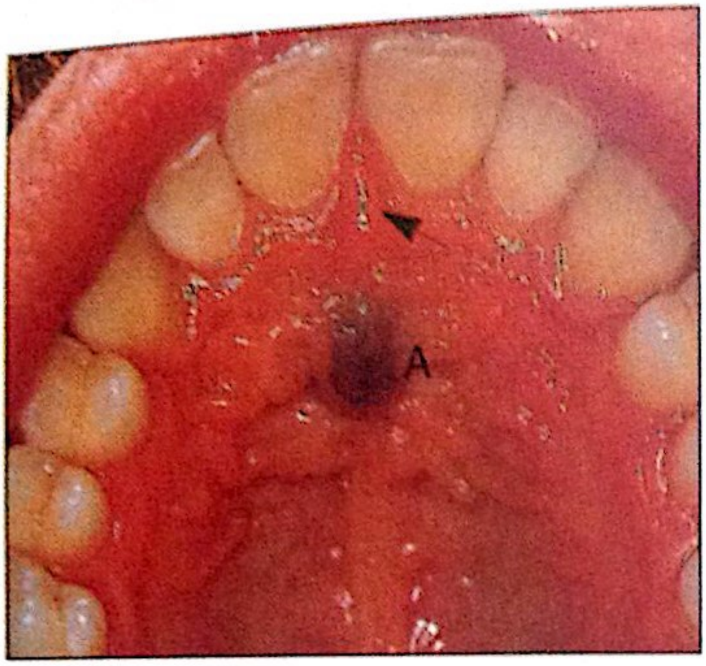


Figure 112

123 During a routine dental examination, the dentist noticed a reddish-blue swelling (A) in the palate immediately behind the maxillary central incisors (*Figure 112*).

(a) Assuming the lesion is of developmental origin, what is the likely cause of the swelling?

(b) What is the name given to the region just in front of the lesion (arrow)?

(c) With which two main anatomical structures is this region normally associated?

124 (*Figure 113*)

(a) What does the structure outlined by the arrows most likely represent in this mandible?

(b) What general factors would cause its spread from the periapical region of the tooth and what specific anatomical structure helps prevent its spread into the face?

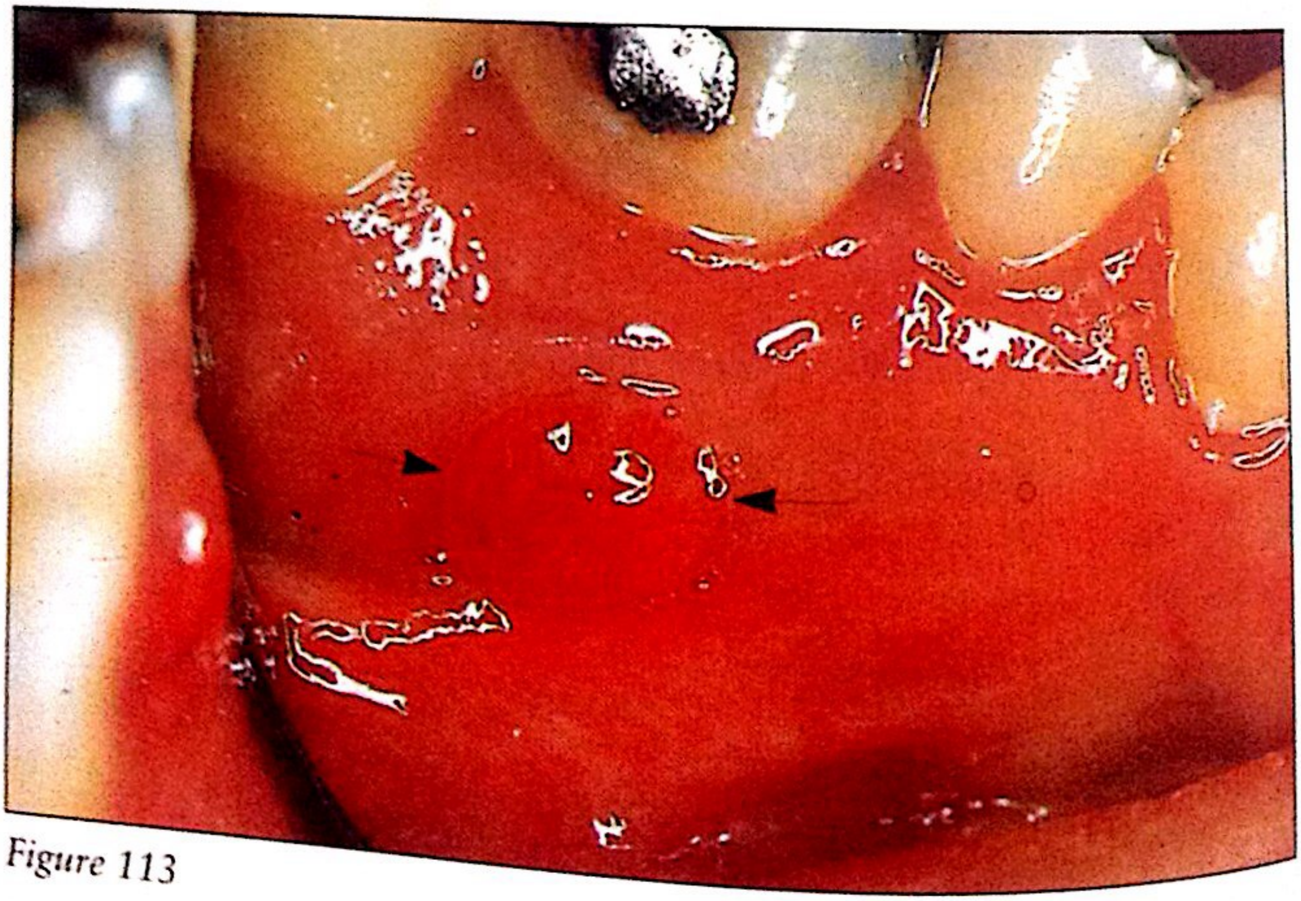


Figure 113

Salivary Glands

125 Which of the following statements are true:

(a) Salivary glands are classified as compound, tubular, acinar, exocrine, and holocrine glands.

(b) Within the substance of the parotid gland, the facial nerve lies deep to the external carotid artery.

(c) The superficial and deep parts of the submandibular gland are separated by the hyoglossus muscle.

(d) The posterior portion of the sublingual gland drains via numerous ducts onto the sublingual fold.

(e) The secretomotor nerve supply for the parotid gland is derived via the greater petrosal nerve.

(f) The glands in the hard palate are of the serous type.

(g) In serous cells, the endoplasmic reticulum is concentrated mainly at the basal end of the cells.

(h) Striated duct cells exhibit numerous infoldings lined by mitochondria on their basal surfaces.

(i) Myoepithelial cells lie between the basal lamina and the basal cell membrane of acinar secretory cells.

(j) Mucous acini can be distinguished from serous acini by their staining with periodic acid Schiff stain.

126 Identify structures A to C in this micrograph of a salivary gland stained with haematoxylin and eosin. *(Figure 114)*

Figure 114

127 Identify the main central structure in this electron micrograph taken from part of a salivary gland *(Figure 115)*.

Figure 115

128 Identify the structure seen in this electronmicrograph by identifying cells A and B. *(Figure 116)*

129 The cell labelled A represents a higher magnification of the cell arrowed in the preceding electron micrograph *(Figure 117)*. What type of cell is it and what is its embryological origin?

Figure 116

Figure 117

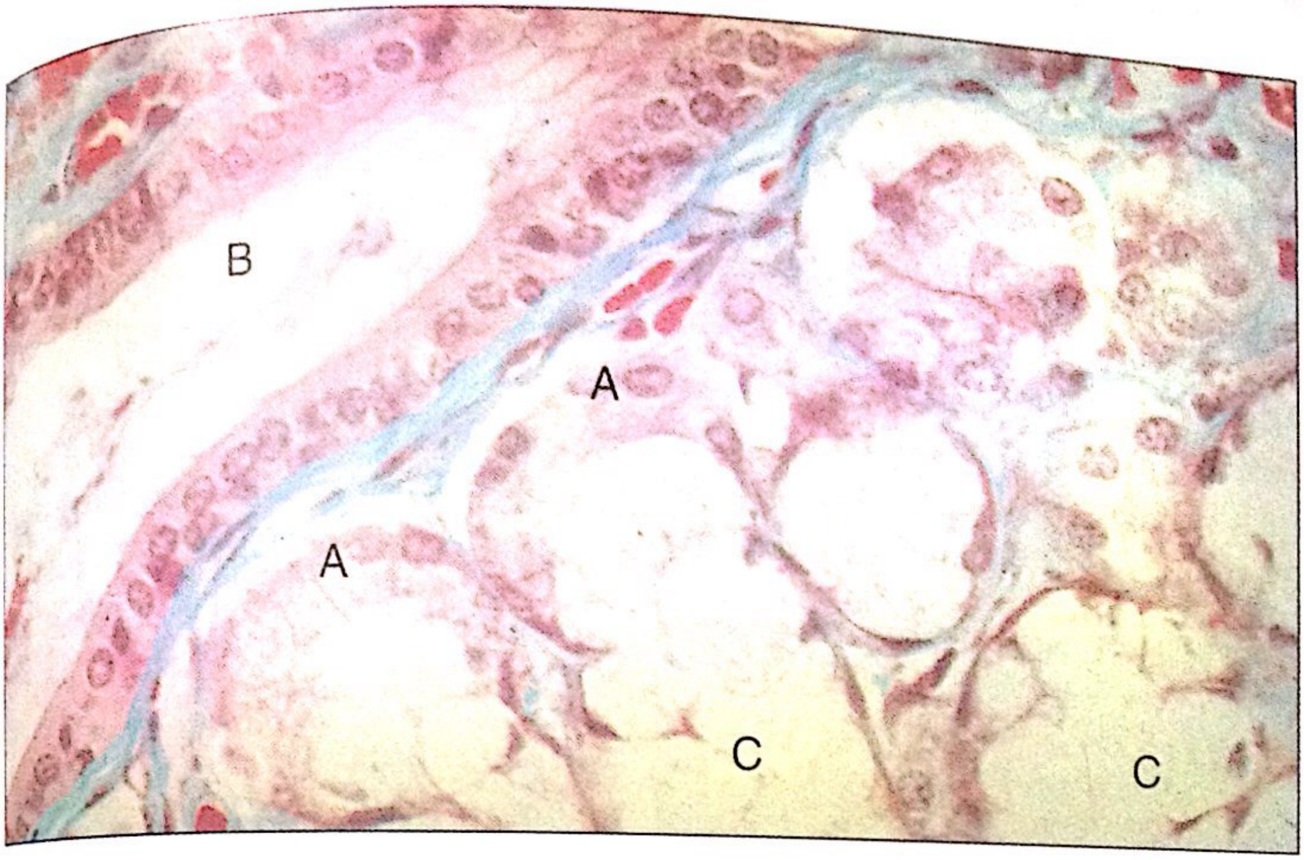


Figure 118

130 *(Figure 118)*
(a) Identify structures A to C in this section of a salivary gland (Masson's trichrome).
(b) Would any differences exist in structure B when it occurs in the sublingual gland compared with the submandibular gland?

131 A 55-year-old man noticed that the right side of the floor of his mouth became swollen at mealtimes, giving him some discomfort. He also complained of a bad taste in his mouth. On examination, there was evidence of inflammation around the opening of the sublingual papilla. Pictured is an occlusal radiograph of the region *(Figure 119)*. What was responsible for his symptoms?

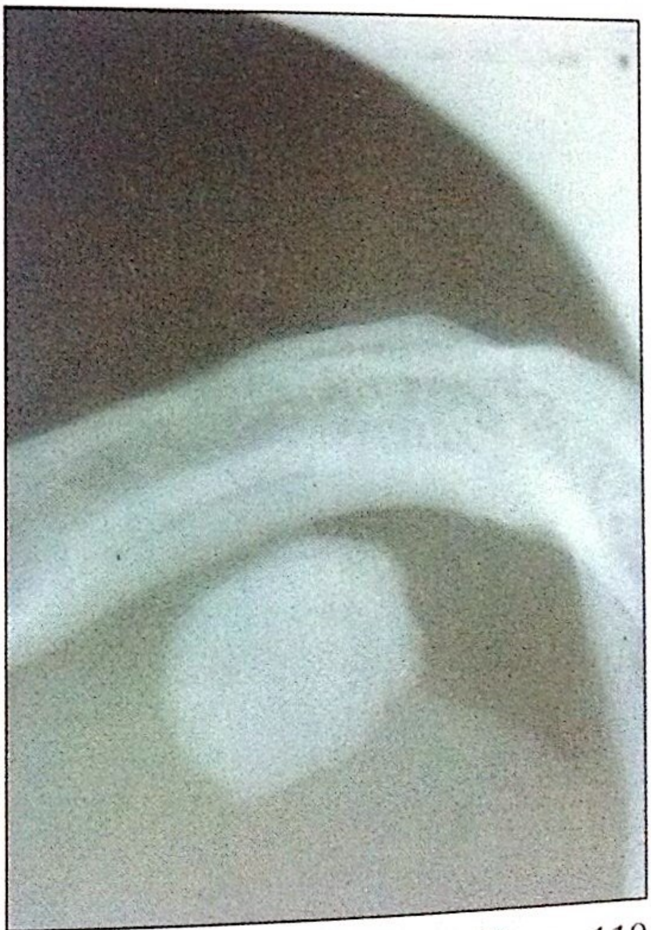


Figure 119

132 The picture presented shows a slow-growing, non-tender encapsulated tumour on the right side of the head *(Figure 120)*.

(a) In terms of the topographical anatomy of the head, in which region does the tumour lie?

(b) Is the tumour likely to be benign or malignant?

(c) The tumour in this region is non-tender and has therefore not affected the nerves located there. Assuming the presence of other lesions which do affect the innervation, what peripheral nerves might become involved?

(d) How may the tumour spread to involve the palate and be associated with dysphagia (difficulty in swallowing)?

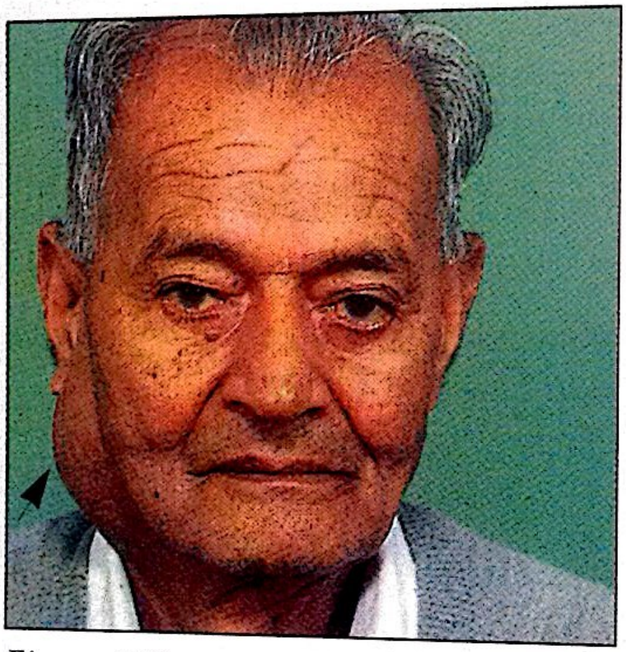


Figure 120

133 A routine radiograph revealed a discrete, radiolucent region close to the angle of the mandible (arrow) *(Figure 121)*. There were no symptoms associated with the lesion. Initially, a cyst was diagnosed but, on showing the radiograph to a consultant, sialograms were taken. Why?

Figure 121

Development of Face, Palate and Tongue

134 Which of the following statements are true:

(a) The facial processes correspond to centres of growth in the underlying mesenchyme.

(b) Ectomesenchyme (neural crest) tissue contributes to the facial processes.

(c) Facial processes are separated from each other by epithelial sheets which must be broken down for normal development.

(d) The nasal placodes are thickenings of ectoderm which derive the olfactory hair cells.

(e) The otic placode gives rise to the bony labyrinth of the internal ear.

(f) The frontonasal process is subdivided into medial and lateral nasal processes around the lens placode.

(g) The maxillary processes initially merge with the medial nasal processes to form the intermaxillary segment.

(h) An oblique cleft of the lip results from the continuance on the surface of the naso-optic furrow.

(i) In the presence of a bilateral cleft lip, the philtrum is innervated by the maxillary nerve.

(j) The primary palate is formed by the frontonasal process.

(k) The palatal shelves forming the secondary palate are outgrowths of the mandibular processes.

(l) Secondary palate formation requires the elevation and then fusion of the palatal shelves in the hard palate but not the soft palate.

(m) Palatal shelf elevation occurs because of external forces produced by the developing tongue.

(n) During palatal shelf elevation, the amount of the glycosaminoglycan called hyaluronan increases markedly within the shelf.

(o) Palatal shelf elevation in humans occurs during the 12th week of intra-uterine life.

(p) During fusion of the palatal shelves, a midline epithelial seam is formed which then breaks down in association with programmed cell death.

(q) Recombination experiments with epithelial and mesenchymal components of the palatal shelves indicate that the epithelium controls mesenchymal behaviour.

(r) Type IX collagen, synthesised under the control of epidermal growth factors, may provide a signal for changes of the midline epithelial seam.

(s) A submucous cleft describes a condition where the palatal mucosa is intact but the underlying bone and musculature are deficient.
(t) The hard palate ossifies intramembranously from a centre in the premaxilla.
(u) The anterior part of the tongue is derived from the second branchial arch.
(v) The developmental division between the anterior and posterior parts of the tongue is shown by the sulcus terminalis.
(w) The accessory nerve may innervate the very back part of the tongue, indicating some contribution from the fourth branchial arch.
(x) The musculature of the tongue is derived from pre-optic myotomes.
(y) The epithelial lining of the tongue is ectodermal in origin.

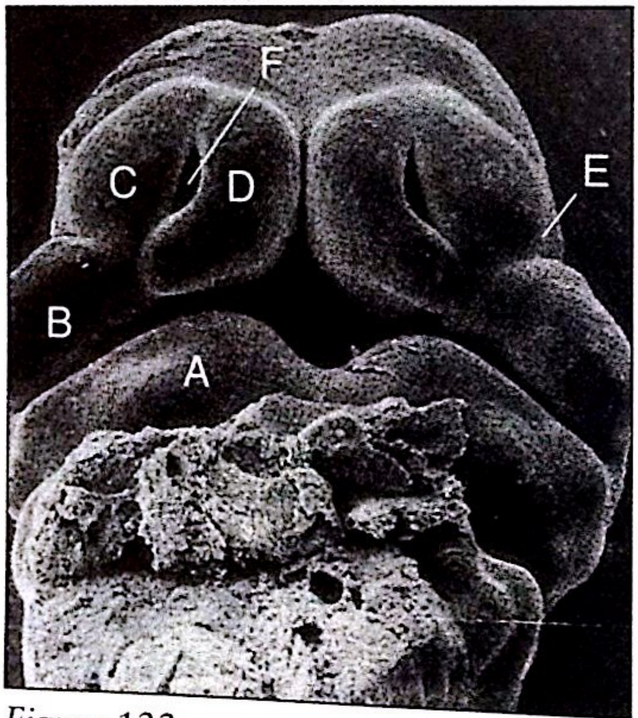


Figure 122

135 The picture provided shows the developing face of a foetus during the 6th week of intra-uterine life *(Figure 122)*.
(a) Identify the features indicated by the labels A to F.
(b) What is the nasal fin and how does it contribute to the development of the upper lip?
(c) What is the evidence that vitamin A derivatives are involved in 'pattern formation' during the development of the upper lip?
(d) List the main types of facial clefts which can appear.

136 Pictured is a coronal section through the developing head of a foetus during the 7th week of intra-uterine life *(Figure 123)*.
(a) Identify the structures indicated by the labels A to E.
(b) By which week is the palate elevated and fused?
(c) What are the mechanisms responsible for the elevation of the palatal shelves?

(d) What are the mechanisms responsible for the fusion of the palatal shelves once they have been elevated?
(e) List the main varieties of clefts of the palate.

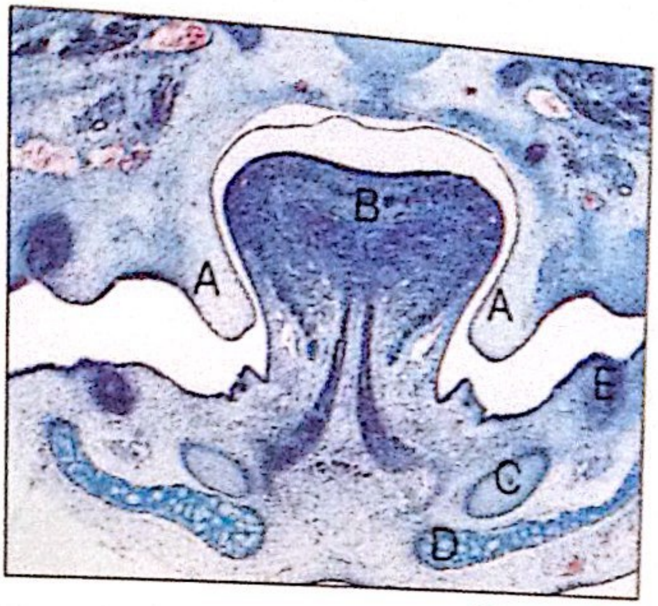


Figure 123

137 In the diagram of the developing tongue provided, identify regions A to C (*Figure 124*).

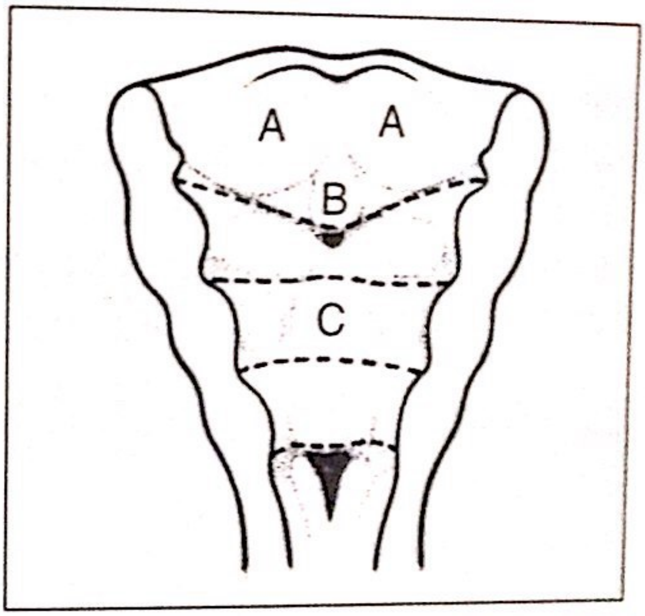


Figure 124

138 The radiograph shows a large, circular, radiolucent area in the centre of the palate (*Figure 125*). On surgical examination, a cyst lined with stratified squamous epithelium was discovered and a median palatine cyst of 'developmental' origin was diagnosed. Bearing in mind the mechanisms involved during palatogenesis, how would you account for the presence of this cyst?

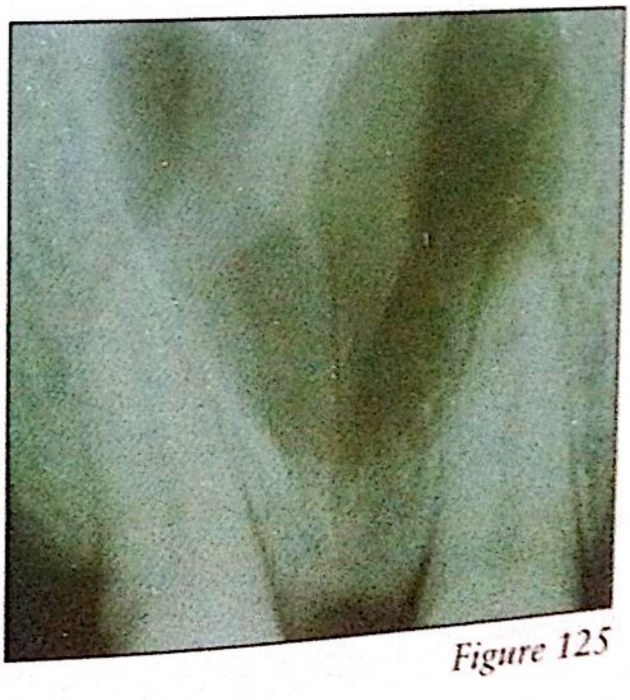


Figure 125

Figure 126

139 The illustration shows a severe cleft of the palate *(Figure 126)*.

(a) What is the incidence of clefts of the palate in human neonates?

(b) What is the mode of inheritance for palatal clefts?

(c) Is the incidence of cleft palate the same in males and females?

(d) From your knowledge of normal palatogenesis, conjecture the mechanisms which may be responsible for palatal clefts.

140 A young man noticed a painless swelling at the back of his tongue in the midline *(Figure 127)*. Thinking it might be a tumour, he visited his local hospital. The examining doctor believed that the lesion was harmless and had an embryological explanation. To confirm this, the doctor conducted a test which showed that the swelling took up radioactive iodine. What might the swelling be?

Figure 127

Development of the Jaws

141 Which of the following statements are true:

(a) Both the maxilla and the mandible initially develop intramembranously.

(b) The centre of ossification for the maxilla appears close to the site of the future deciduous central incisor tooth during the eighth week of intra-uterine life.

(c) Unlike the mandible, the maxilla receives no significant contributions from secondary cartilages.

(d) Growth of the maxilla is dependent upon forces exerted externally from the growing brain, eye and nasal septum.

(e) Forward growth of the lower jaw is greater than that of the upper jaw.

(f) The maxillary air sinus does not develop until 3 years after birth.

(g) The initial centres for ossification for the mandible lie close to the divisions of the inferior alveolar nerves into incisive and mental branches.

(h) The secondary cartilage within the mandibular condyle is essential for growth of the ramus.

(i) Remodelling of the ramus of the mandible involves resorption of bone on the anterior border and deposition on the posterior border.

(j) The mandibular symphysis closes 1 year after birth.

142 The photomicrograph shown is a transverse section through the early developing mandible (8th week of development) (*Figure 128*).

(a) Identify the structures labelled A to D.

(b) What is Meckel's cartilage and to what does it contribute in the adult?

(c) Briefly describe the development of the temporo-mandibular joint.

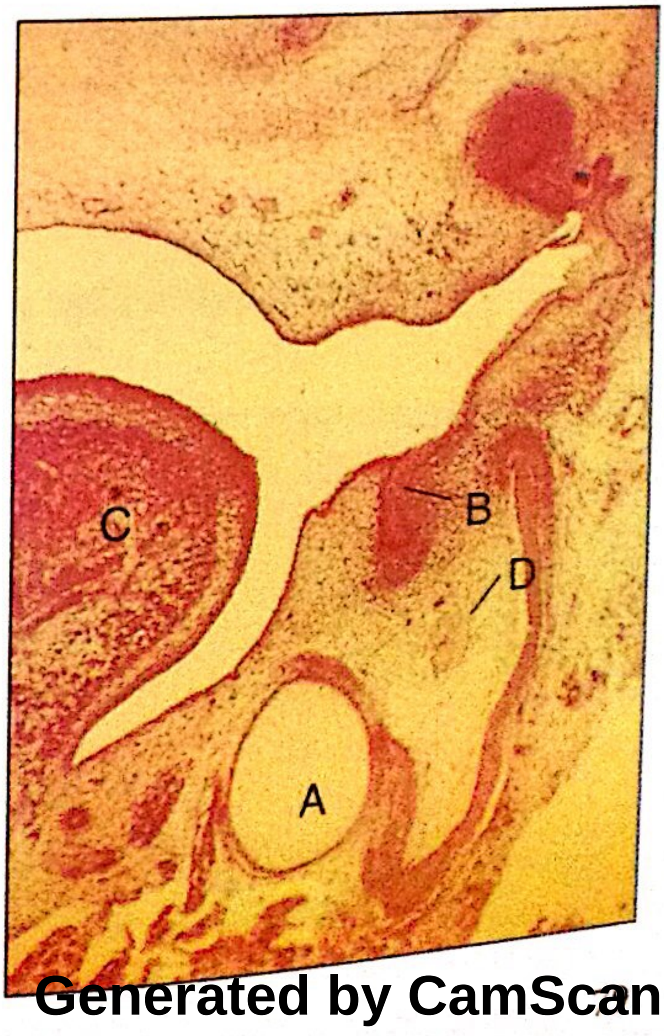


Figure 128

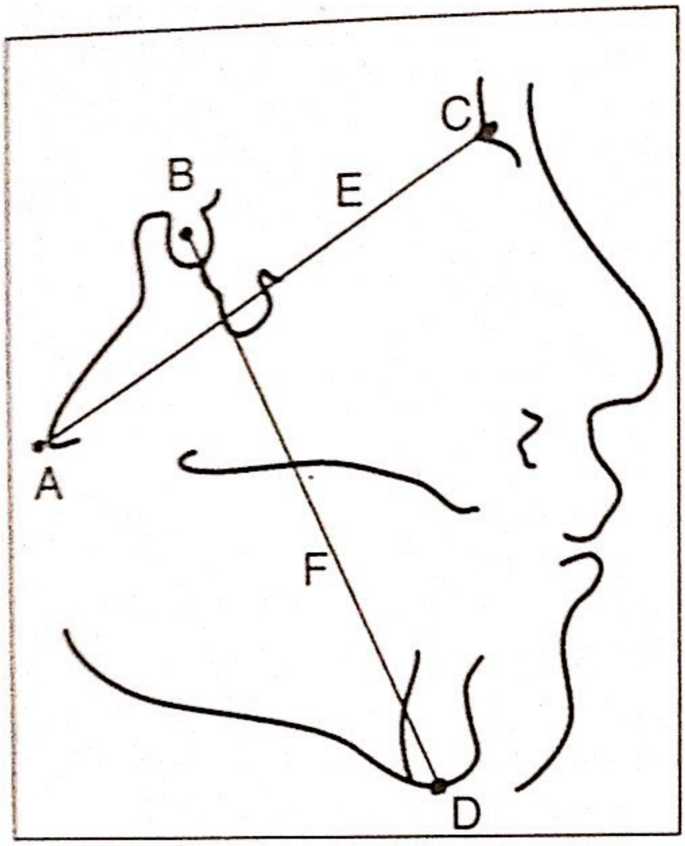


Figure 129

143 The drawing (*Figure 129*) depicts a tracing taken from a lateral skull radiograph produced using a cephalostat.

(a) Label the various features indicated on the drawing (A to F) which are used to assess growth of the skull.

(b) What mechanisms are involved in the postnatal development of the mandible?

(c) List the 'skeletal units' of the mandible with their corresponding soft tissue 'functional matrices'.

(d) What mechanisms are involved in the postnatal development of the maxilla?

144 (*Figure 130*)

(a) Identify the tissue labelled A.

(b) Identify its situation in the skull of a 10-year-old child.

(c) Classify the tissue labelled B at the edges of the micrograph.

(d) How could this region be distinguished from the growth plate in a long bone?

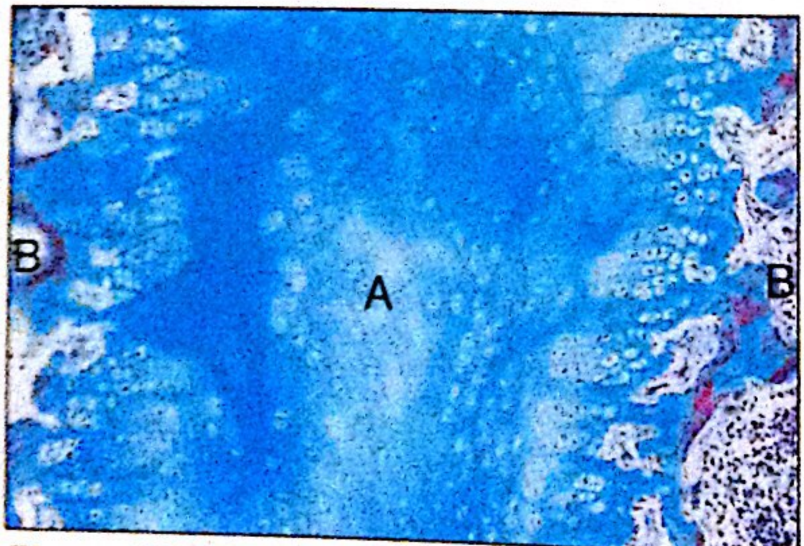


Figure 130

145 The abnormality to the lower jaw shown in the picture (*Figure 131*) resulted from damage to the condyles during a forceps delivery. How would you account for the resulting deformity?

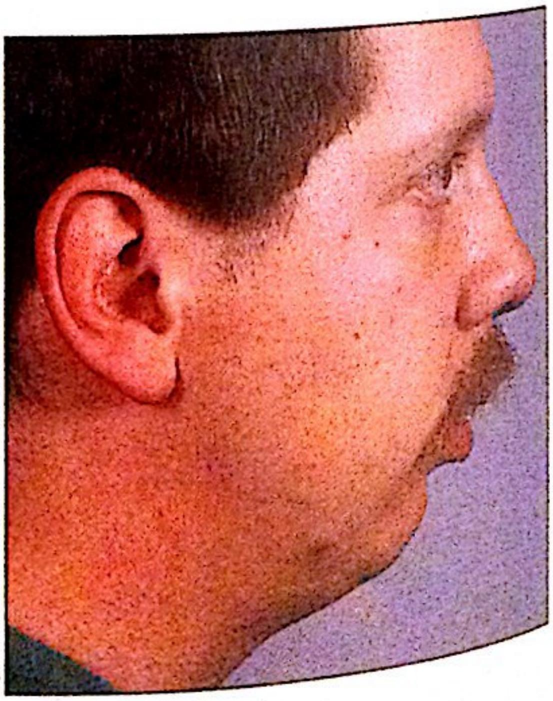


Figure 131

146 Which of the following statements are true:

(a) Tooth germs at the early bell stage of development can be seen by the 8th week of intra-uterine life.

(b) The vestibular lamina lies lingual to the dental lamina.

(c) At the cap stage of development, combination in culture of an incisor enamel organ and a molar dental papilla gives rise to an incisor-shaped tooth when allowed to develop further.

(d) The stratum intermedium is a single layer of cells lying between the internal enamel epithelium and stellate reticulum.

(e) The stratum intermedium is rich in RNA.

(f) The cementum and periodontal ligament originate from the dental follicle.

(g) Stellate reticulum cells show tonofilaments.

(h) Continued differentiation of the cells does not occur when an enamel organ and dental papilla are cultured on either side of a millipore filture with a pore size of 1 μm.

(i) The enamel cord is a transient group of cells extending from the stratum intermedium into the stellate reticulum.

(j) The enamel organ is derived from ectomesenchyme (neural crest) cells.

147 (*Figure 132*)

(a) Which stage of tooth development is illustrated here and when is it first reached?

(b) Identify A to E.

(c) What biochemical substance characterises A?

(d) What is the name of region F?

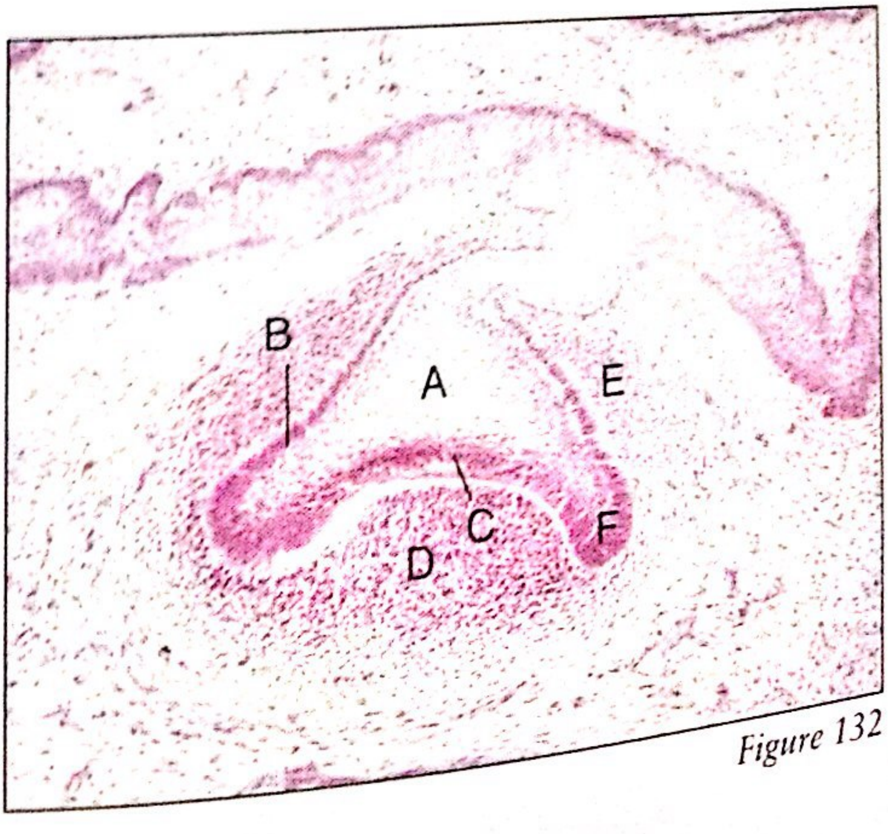


Figure 132

Figure 133

148 *(Figure 133)*

(a) What stage of development is illustrated here?

(b) Identify A to E. What is the possible function of D?

(c) Is the lingual side situated to the right or left of this micrograph?

149 The two pictures below are of patients affected by hereditary ectodermal dysplasia. *Figure 134* is of a 6-year-old child, *Figure 135* an 8-year-old child. What do you deduce are the main dental signs of this disorder?

Figure 134

Figure 135

Enamel Development

151 Which of the following statements are true:

(a) Secretory ameloblasts are approximately 5μm wide and 15μm long.

(b) During reversal of polarity within the ameloblast, the Golgi complex migrates to the distal end of the cell.

(c) In young immature enamel, the ratio of amelogenins to non-amelogenins (enamelins) is about 19:1.

(d) The daily rate of enamel formation is greater at the enamel surface than at the central region.

(e) As for dentine, the initiation of enamel mineralisation occurs by means of matrix vesicles.

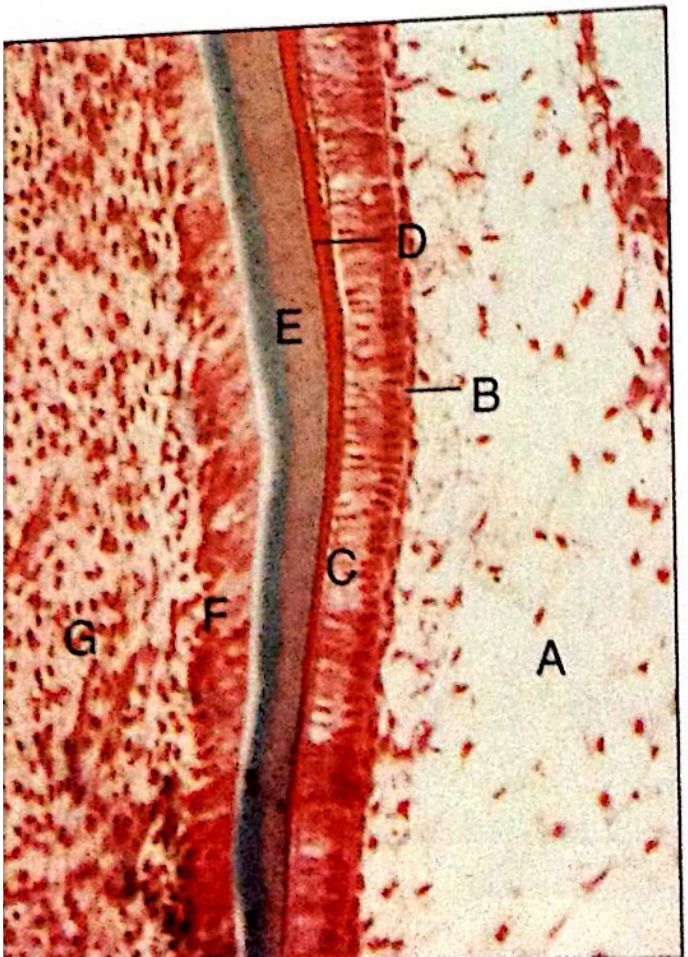
(f) Ameloblasts are hexagonal in cross-section.

(g) Prismless enamel can be correlated with the width of the Tomes process.

(h) Nasmyth's membrane comprises the reduced enamel epithelium and the primary cuticle.

(i) A thin, unmineralised layer, about 2μm thick, exists at the formative enamel surface.

(j) Amelogenins are hydrophobic molecules of molecular weight 55,000.



152 *(Figure 138)*

(a) Identify A to G.

(b) What is the principal amino-acid of D and E?

(c) Has reversal of polarity occurred in the cells in layer A at the bottom of the micrograph?

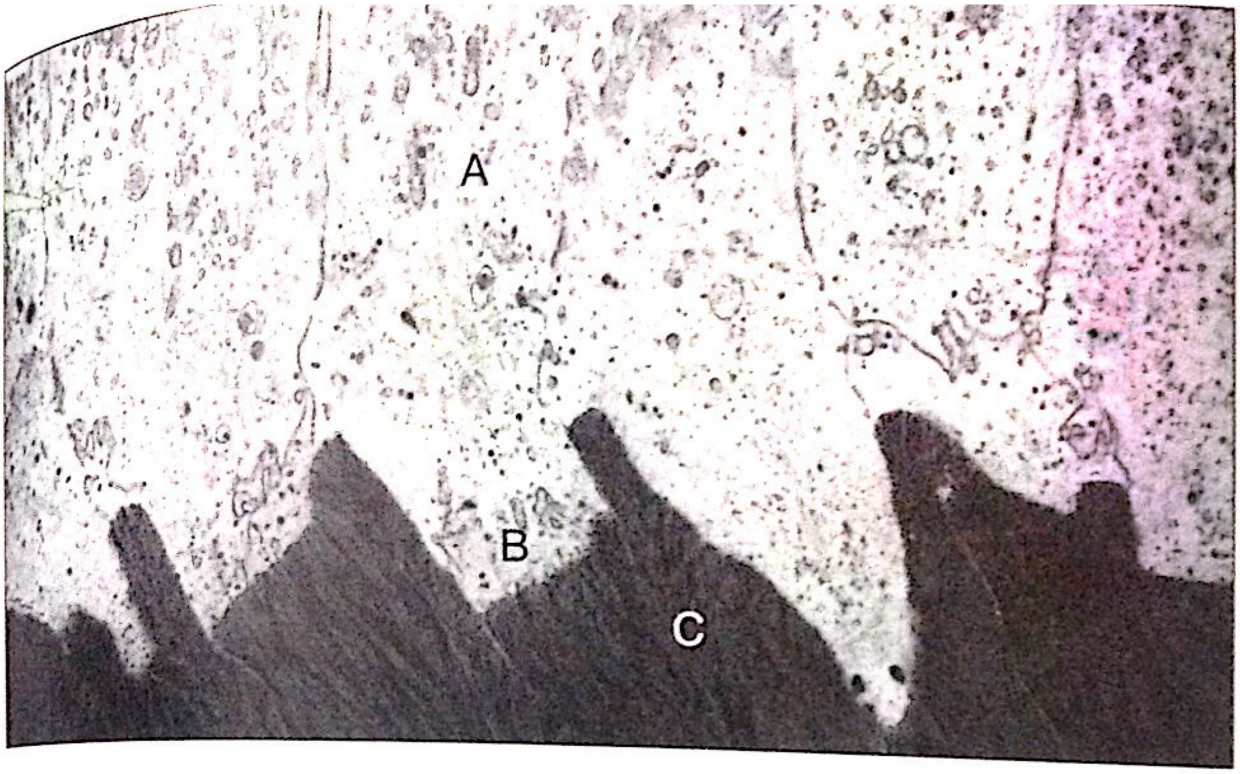


Figure 139

153 *(Figure 139)*
(a) Identify A to C.
(b) What structural feature 'separates' A and B?
(c) What is the relationship of B to the basic structure of enamel?

154 What may be responsible for the appearance of the enamel? *(Figure 140)*

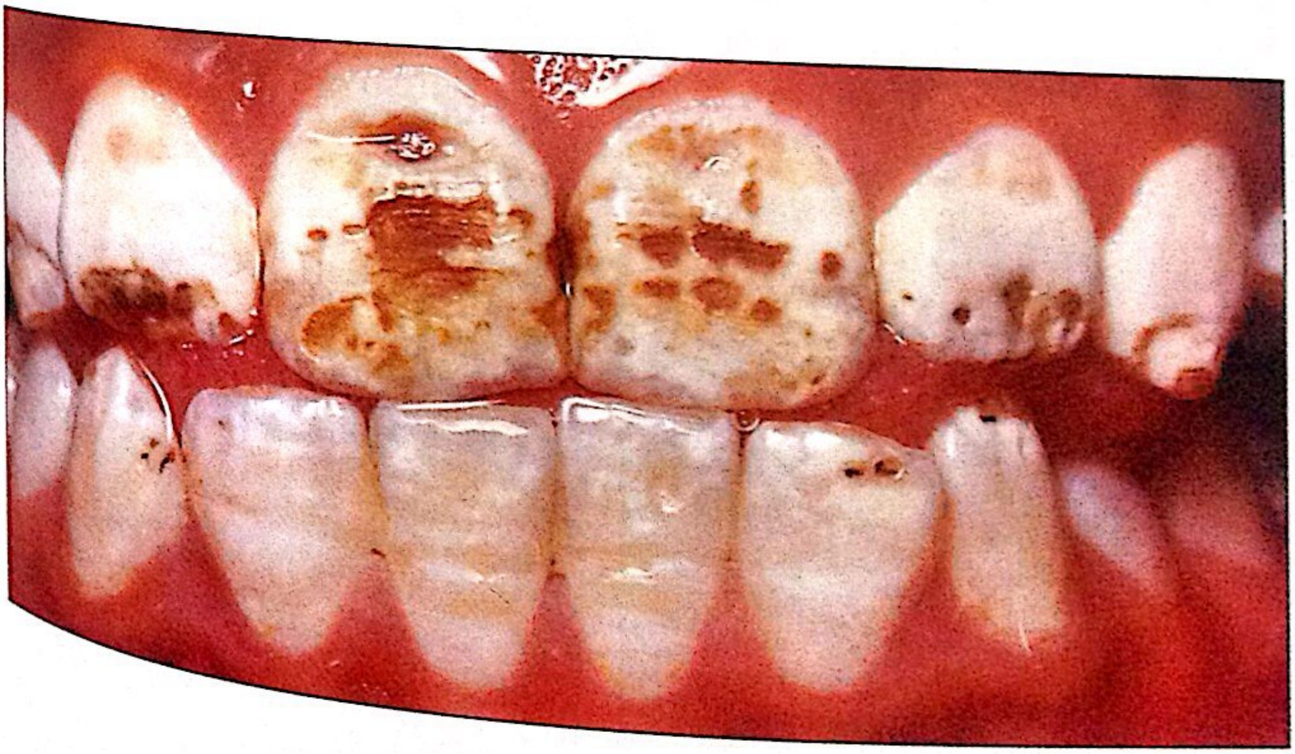


Figure 140

Development of the Dentine and Pulp

155 Which of the following statements are true:

(a) Both the dentine and the dental pulp originate from the dental papilla of the tooth germ.

(b) Dentinogenesis commences immediately after amelogenesis.

(c) The first formed dentine, the mantle dentine, may contain some collagen derived from subodontoblastic cells.

(d) The cells forming the dentine and pulp are mesodermal in origin.

(e) Unlike the fully formed dental pulp, the developing pulp has little glycosaminoglycan (GAG).

(f) The pattern of innervation of the dental pulp is established during the cap stage of tooth development.

(g) Mineralisation of dentine occurs initially by the budding off of matrix vesicles from odontoblast cell bodies.

(h) Mineralisation of dentine commences when the full thickness of the dentine has been formed.

(i) There is both a spherical and a linear pattern of mineralisation of dentine.

(j) Dentinogenesis imperfecta is an autosomal dominant genetic condition.

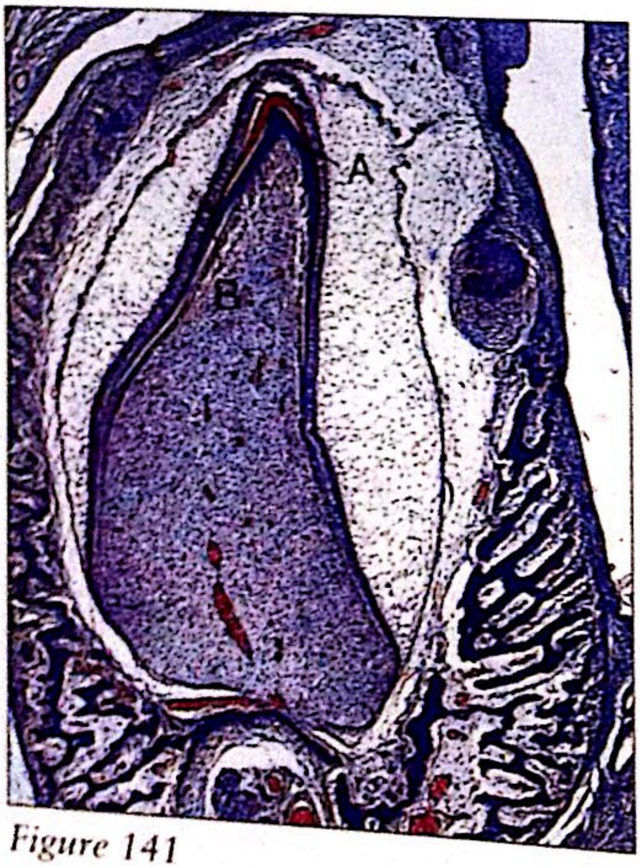


Figure 141

156 Pictured is a developing tooth at the late bell stage of development (*Figure 141*).

(a) Identify the red tissue (A) and the blue tissue (B).

(b) In both developmental and structural terms, how does the first formed dentine differ from the bulk of the circumpulpal dentine?

(c) What are the special features of dentine formation in the root?

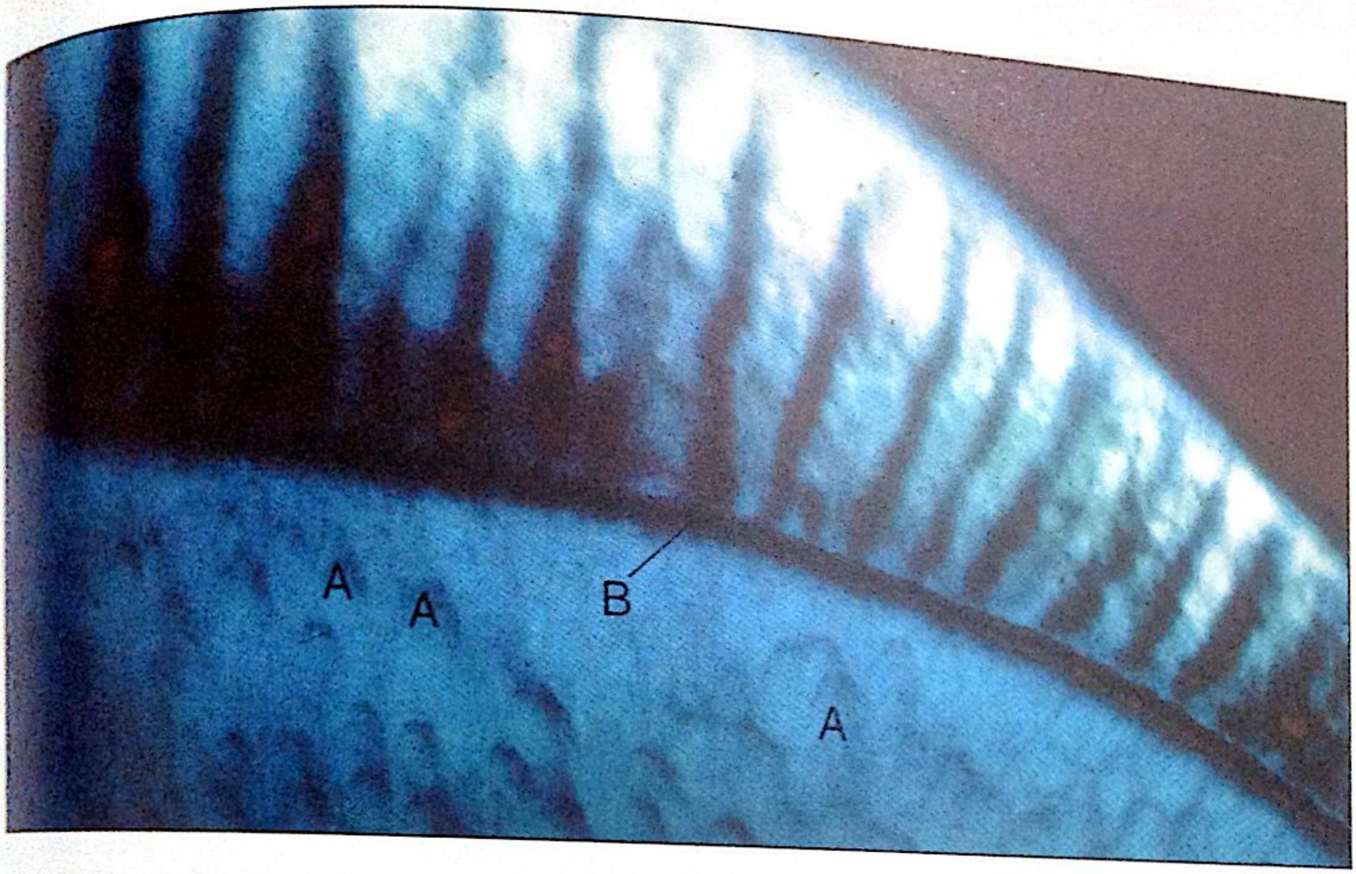


Figure 142

157 Some developmental features can be seen in the dentine of a fully formed tooth viewed under polarised light. Identify the features labelled A and B on the illustration shown here. *(Figure 142)*

158 Distinguish between the two processes seen in these anorganic preparations viewed in the scanning electron microscope. *(Figures 143 and 144)*

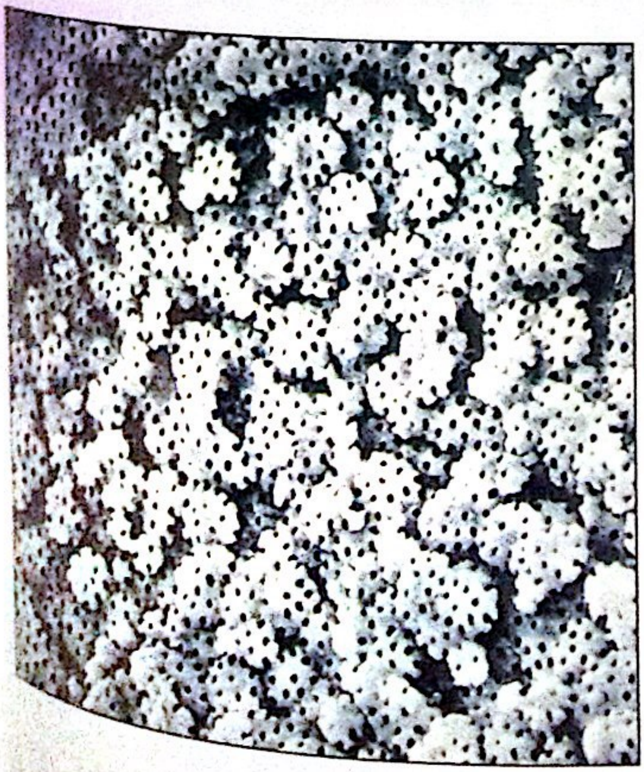


Figure 143

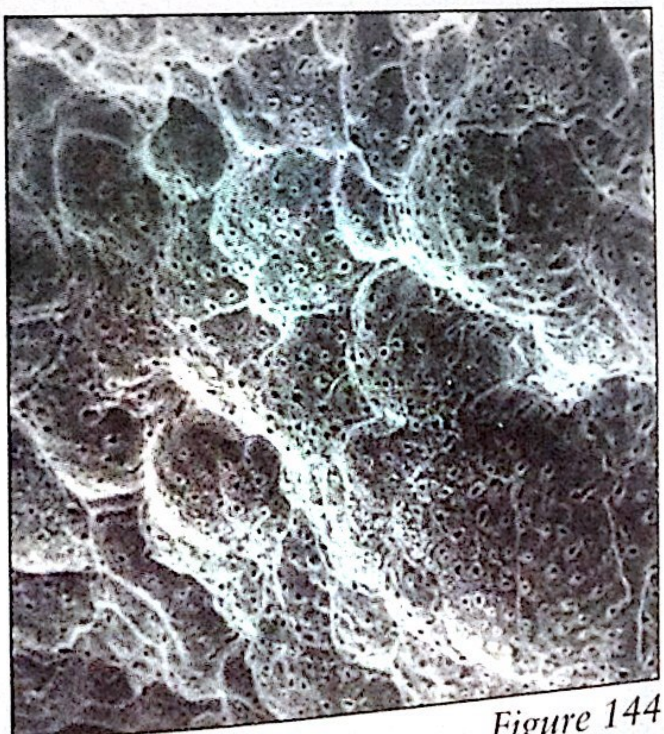


Figure 144

159 The radiograph (*Figure 145*) and decalcified section (*Figure 146*) are of an abnormally formed tooth (arrow) since it appears that a tooth is developing within a tooth (known as 'dens in dente'). From your understanding of normal tooth development, how would you account for this abnormality?

Figure 145

Figure 146

Development of the Periodontium

160 Which of the following statements are true:

(a) Root development commences immediately after crown formation.

(b) The epithelial root sheath comprises the internal and external enamel epithelia, separated by the stratum intermedium.

(c) As with the crown, the internal enamel epithelial cells of the root sheath enlarge during their inductive stage.

(d) Cells of the epithelial root sheath give rise to cementoblasts.

(e) Principal fibres of the periodontal ligament are poorly organised at the time of eruption in succedaneous teeth.

(f) As for dentine, calcospherites can be observed during the mineralisation of cementum.

(g) Like the formation of bone, a layer of unmineralised cementum matrix a few microns thick is seen during cementogenesis.

(h) The pulp limiting membrane is attached at its margins to alveolar bone.

(i) Coronal cementum can be deposited on enamel following degeneration of the reduced enamel epithelium.

(j) In multi-rooted teeth, ingrowth of the epithelial shelves from the root sheath takes place along paths of high vascularity.

161 Label A to H. *(Figure 147)*

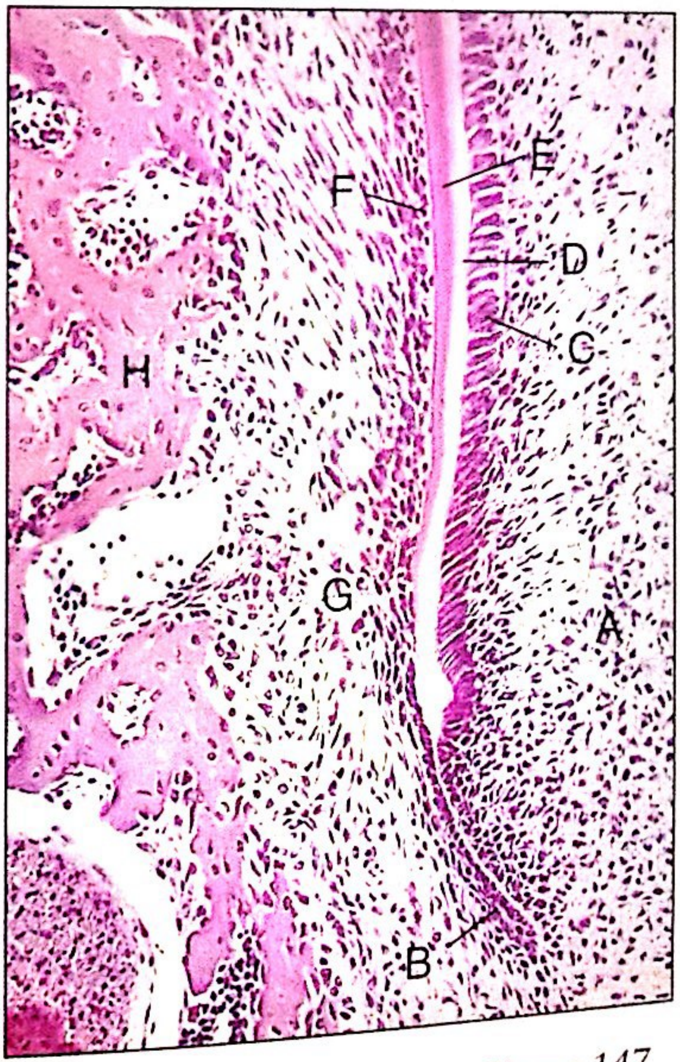


Figure 147

Figure 148

162 *(Figure 148)*
(a) Identify A to D.
(b) List three possible functions for B.
(c) What is the fate of B?
(d) What is the principal protein component of C?

163 Identify A to D. *(Figure 149)*

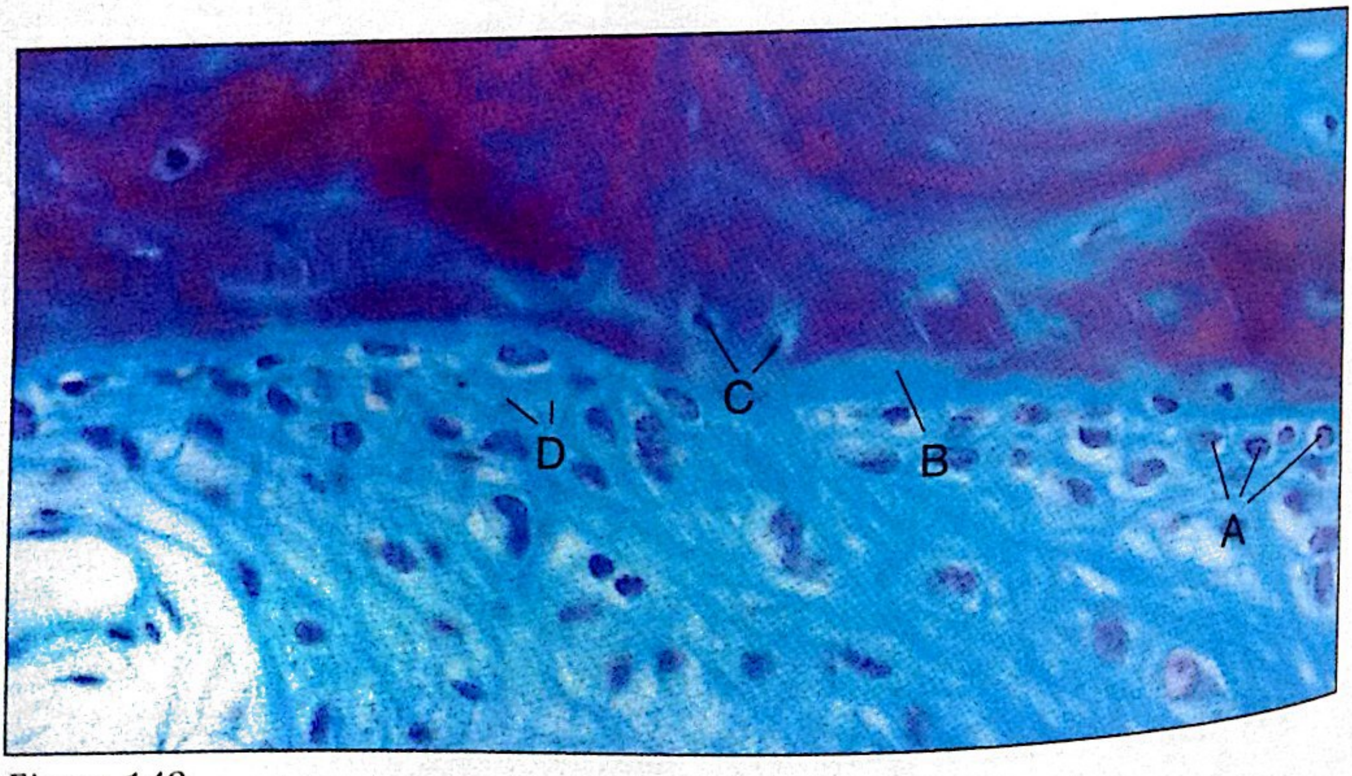


Figure 149

164 *(Figure 150)*

(a) Identify structure A.

(b) Account for its formation.

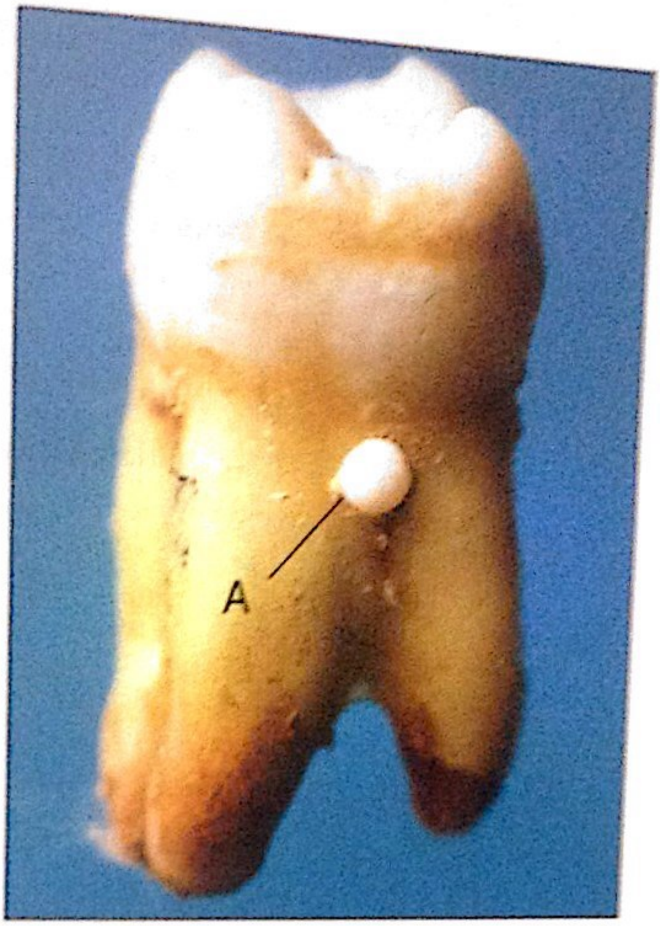


Figure 150

165 *(Figure 151a&b)*

(a) Identify the structure arrowed.

(b) How does it originate?

(c) What is its clinical significance?

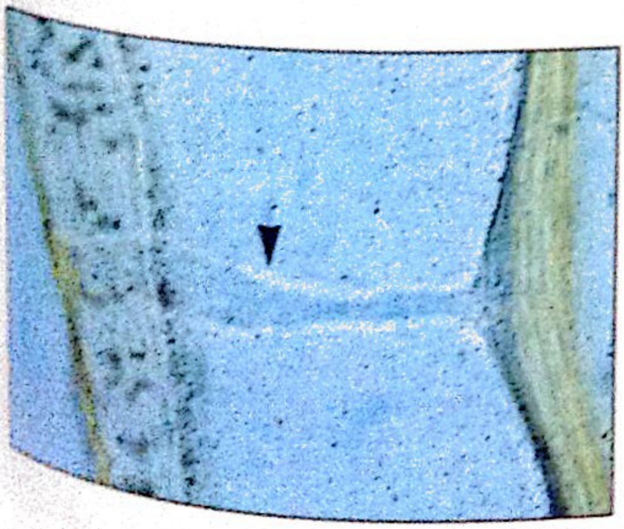


Figure 151a

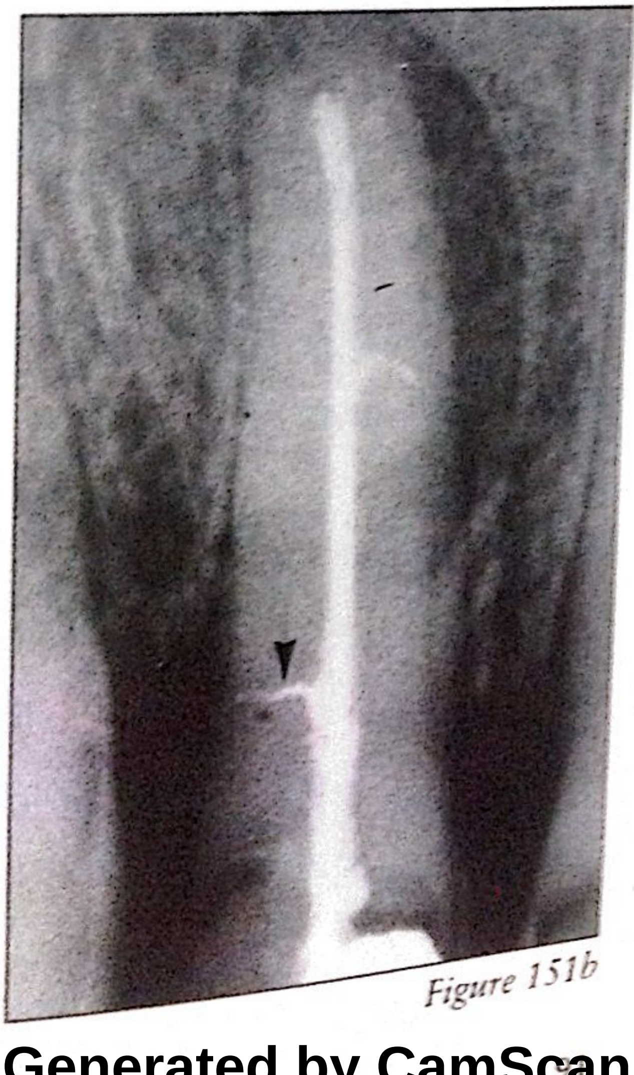


Figure 151b

166 Which of the following statements are true:

(a) The deciduous maxillary first molar erupts into the mouth at 2 years of age.

(b) The permanent mandibular second molar erupts into the mouth between 12 and 13 years of age.

(c) The permanent mandibular canine commences calcification at 1 year.

(d) The permanent maxillary first incisor completes calcification of its crown between 4 and 5 years of age.

(e) The root of the permanent mandibular first molar is completed 1 year after the tooth has erupted into the mouth.

(f) Between the ages of 6 and 13 years, the human dentition is described as a 'mixed' dentition.

(g) At birth, the 20 gum pads corresponding to the unerupted deciduous teeth are often brought into a functional occlusion.

(h) At 5 years of age, the deciduous incisors show considerable wear and often occlude edge-to-edge.

(i) Spacing of the deciduous dentition is uncommon.

(j) The first permanent molars often erupt with a cusp-to- cusp relationship.

(k) Postpubital loss of space anteriorly may result from forces exerted by the permanent third molar teeth.

(l) Prior to their emergence into the mouth, each deciduous tooth is overlain by a gubernacular canal.

(m) The cells responsible for the resorption and shedding of deciduous teeth are distinct in origin and form from osteoclasts responsible for bone resorption.

(n) As a tooth erupts through the oral mucosa, its reduced enamel epithelium becomes the initial junctional epithelium.

(o) Following the loss of an antagonist tooth in the opposite jaw, a tooth often 'over-erupts'.

(p) When viewing an orthopantomogram of a child aged 9 years, the following permanent teeth would be expected to have erupted: all incisors and canines, and the first and second molars.

(q) The main phase of axial tooth eruption begins prior to root formation.

(r) Experiments involving root resection of the rodent incisor indicate that the eruptive force(s) is generated within the dental pulp.

(s) Hypotensive agents acting on the dental vasculature are associated with decreased eruption-like movements.
(t) *In vitro* studies suggest that the periodontal fibroblasts may have contractile or migratory properties which might explain tooth eruption.

167 From the orthopantomogram *(Figure 152)*, provide the dental age for the patient.

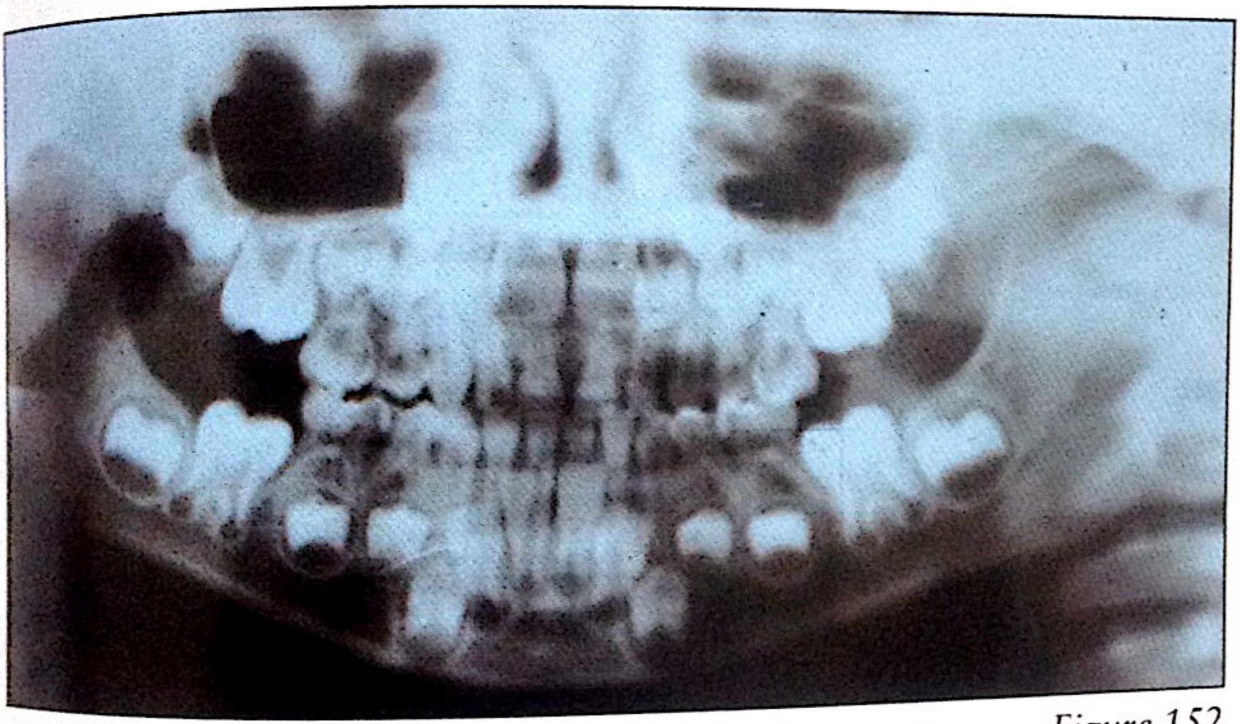


Figure 152

168 From the orthopantomogram *(Figure 153)*, provide the dental age for the patient.

Figure 153

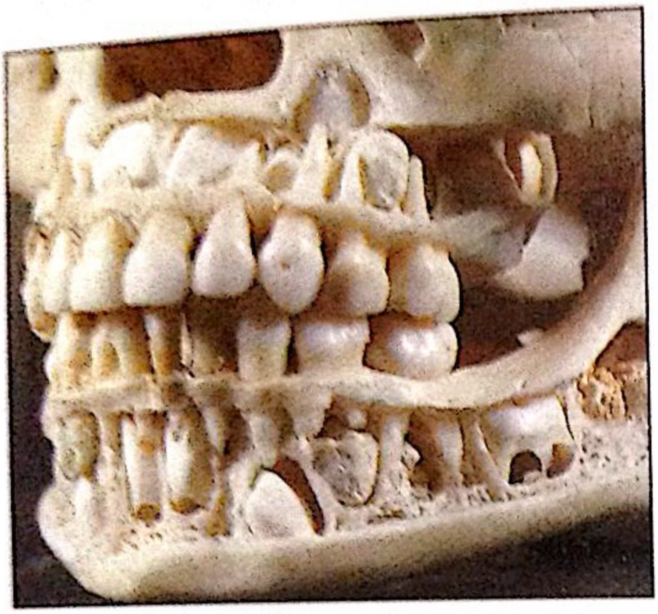


Figure 154

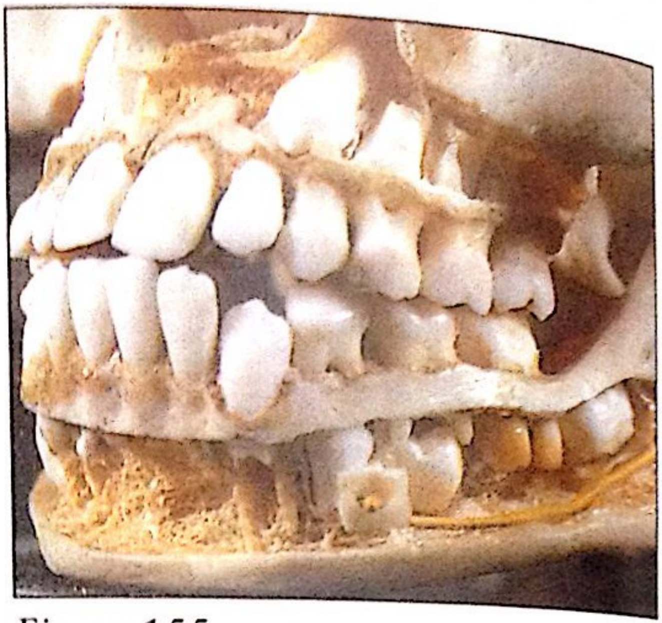


Figure 155

169 Age this skull, briefly giving reasons for your answer. *(Figure 154)*

170 Age this skull, briefly giving reasons for your answer. *(Figure 155)*

171 *(Figure 156)*

(a) What abnormality is evident on this orthopantomogram?

(b) How would you attempt to explain the cause of the abnormality?

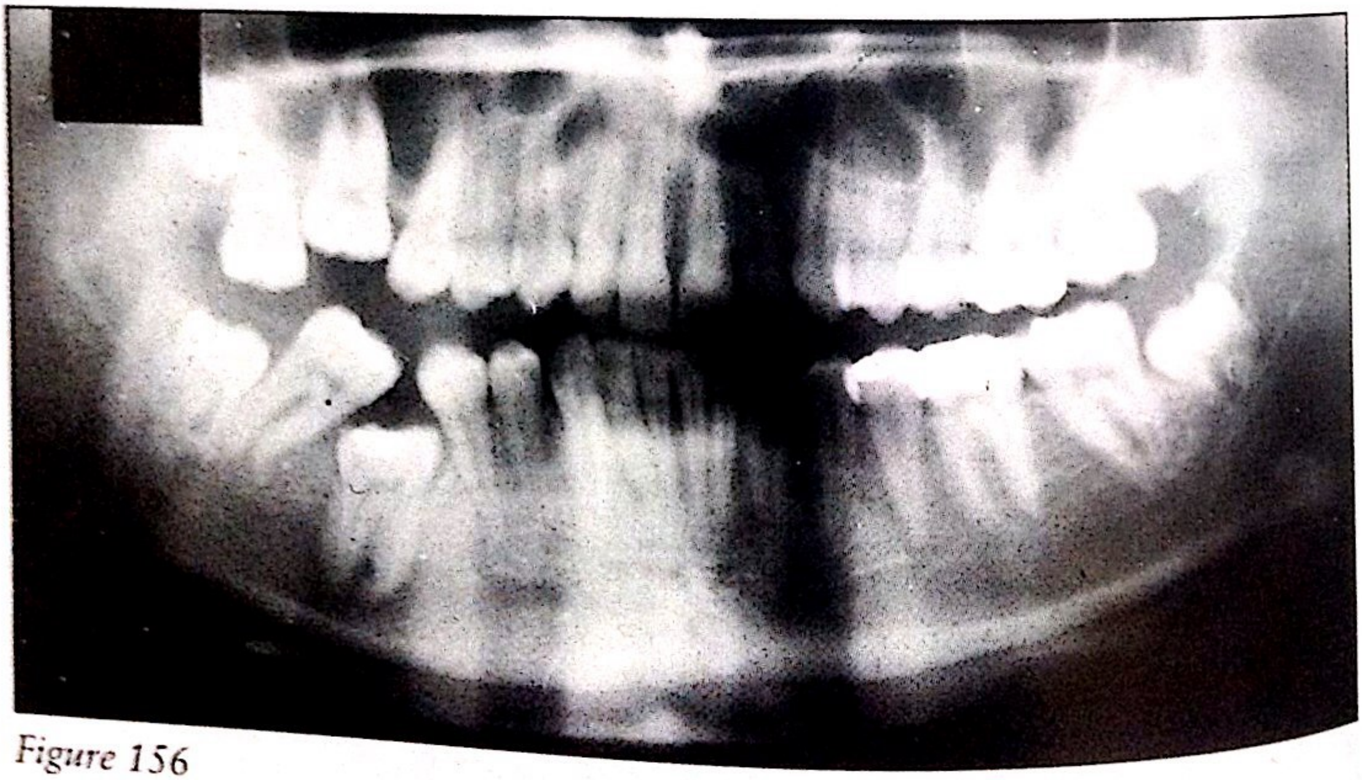


Figure 156

172 The light micrograph (*Figure 157*) is of a deciduous tooth being replaced by a permanent tooth.
(a) Identify the structures indicated by the labels A to C.
(b) What is the pattern of resorption of a deciduous mandibular canine tooth and how would you distinguish the root of a tooth which has been resorbed from one which has been fractured and also from a root which shows incomplete development?
(c) What are the changes which take place in the soft tissues overlying the crown of an erupting deciduous tooth?
(d) What is the evidence indicating that the force(s) of eruption is generated by pressure within the periodontal ligament and not by a tractional force through its collagen network?

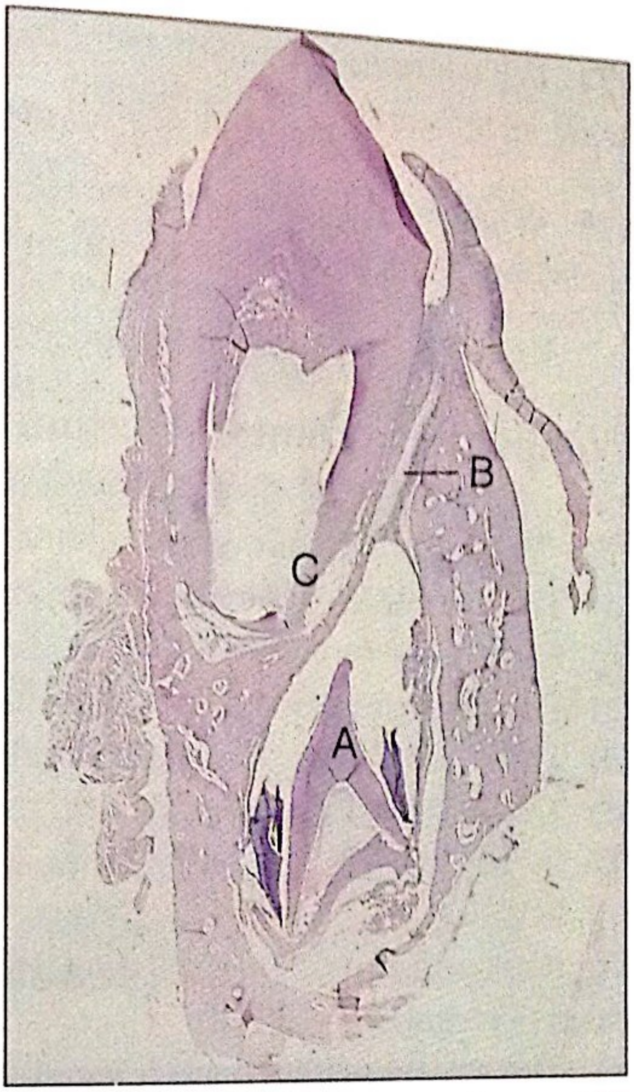


Figure 157

173 What unusual features are evident in this orthopantomogram of a 25-year-old patient? (*Figure 158*)

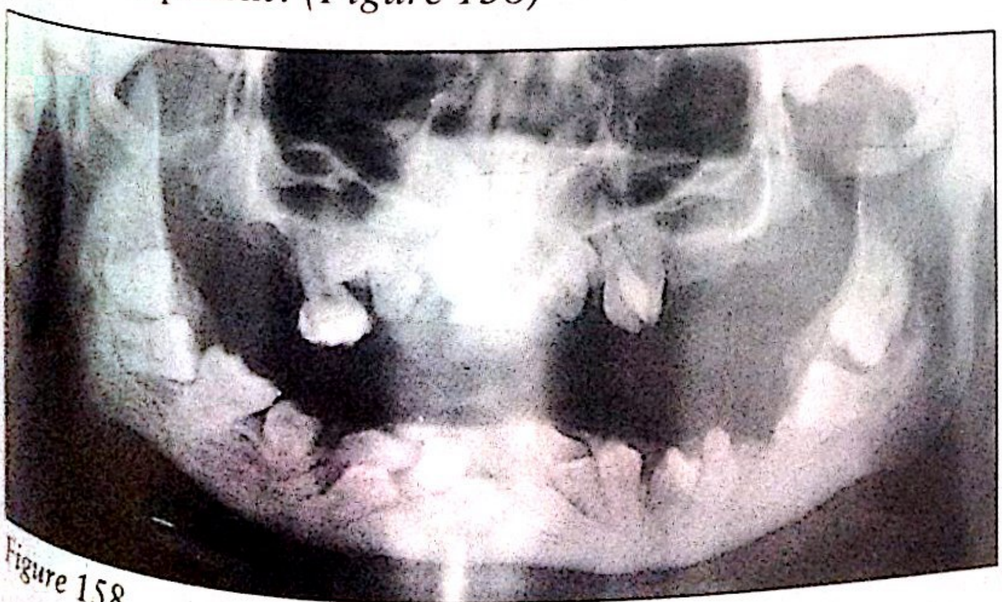


Figure 158

174 What structures may present barriers to an erupting tooth and thereby delay its appearance in the mouth?

175 What are the various stages taken to achieve a 'normal' (anatomical) occlusion of the permanent dentition from the deciduous dentition?

Comparative Dental Anatomy

176 Which of the following statements are true:
(a) The mandible of the chimpanzee exhibits a simian shelf.
(b) Rabbits are monophyodont.
(c) The most posterior premolars form the carnassial teeth in the Carnivora.
(d) The dog has four premolars and three molars in each quadrant.
(e) The deciduous teeth in the dog have all erupted six weeks after birth.
(f) In the pig, the third molar is the largest.
(g) In sheep, the mandibular canine is incisiform.
(h) As for man, only the first permanent mandibular molar in apes usually has five cusps.
(i) The molars of sheep are hypsodont.
(j) The squirrel monkey, a New World Monkey (Cebidae), has three premolars and three molars in each quadrant.
(k) The molars of New World Monkeys decrease in size from before backwards.
(l) The cusps of the molars of the sheep are crescent-shaped (selenodont).
(m) The maxillary premolars in the chimpanzee have three roots.
(n) A sagittal crest is always found in female gorillas.
(o) The mandibular first premolar in apes is predominantly unicuspid.
(p) The canines of *Australopithecus afarensis* did not project above the occlusal plane and therefore a diastema was absent.
(q) The cranial capacity of *Australopithecus africanus* was about 650cm^3.
(r) Because of its large molar teeth, Homo habilis has been knicknamed 'Nutcracker Man'.
(s) Unlike *Homo sapiens*, the broadest part of the skull of *Homo erectus* was towards the base.
(t) From study of incremental lines in enamel, there is evidence that the growth periods of the australopithecines were markedly extended relative to those of modern man.

177 *(Figure 159)*

(a) Identify this skull.

(b) What is the dental formula for this animal?

(c) Is this dentition diphyodont?

(d) What is the average daily rate of incisor eruption?

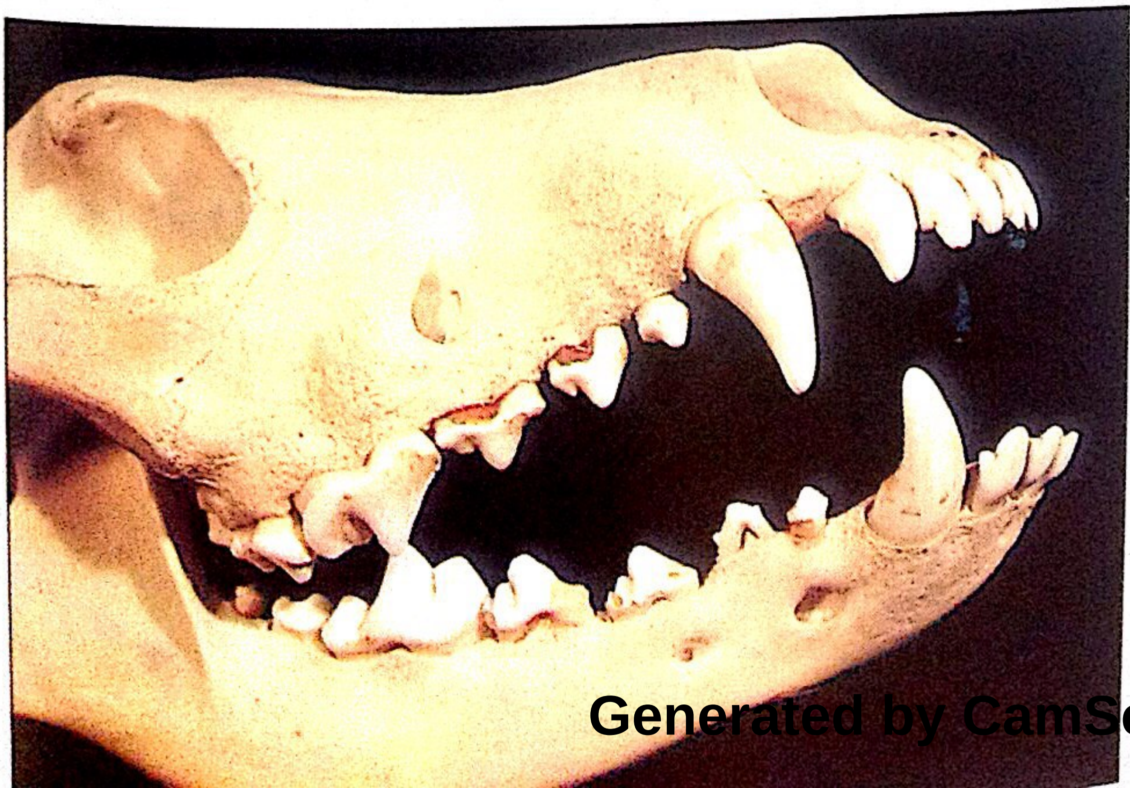
(e) What is responsible for the colouration of the incisors?

(f) Does enamel cover all the coronal dentine?

(g) Describe the alignment of the condyle.

Figure 159

178 Identify this skull. *(Figure 160)*



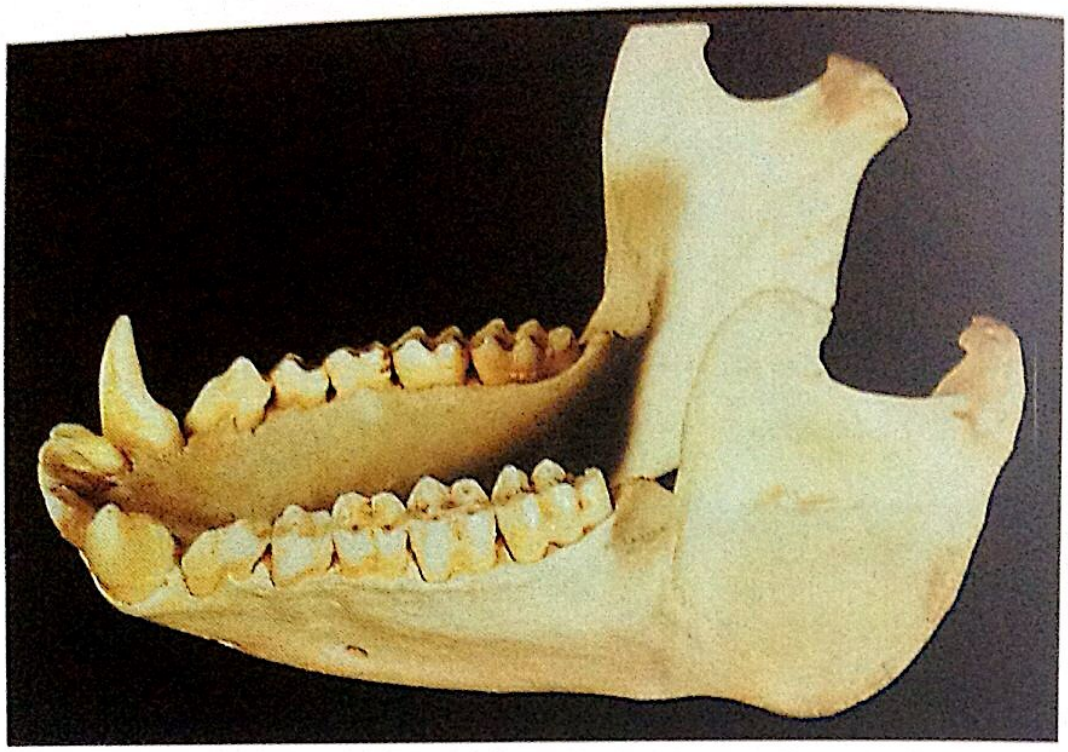


Figure 161

179 *(Figure 161)*

(a) Identify the family to which this mandible belongs.

(b) What is the dental formula for both the deciduous and permanent dentitions?

(c) Comment on the first mandibular premolar.

(d) Describe briefly the characteristic features of the mandibular molars.

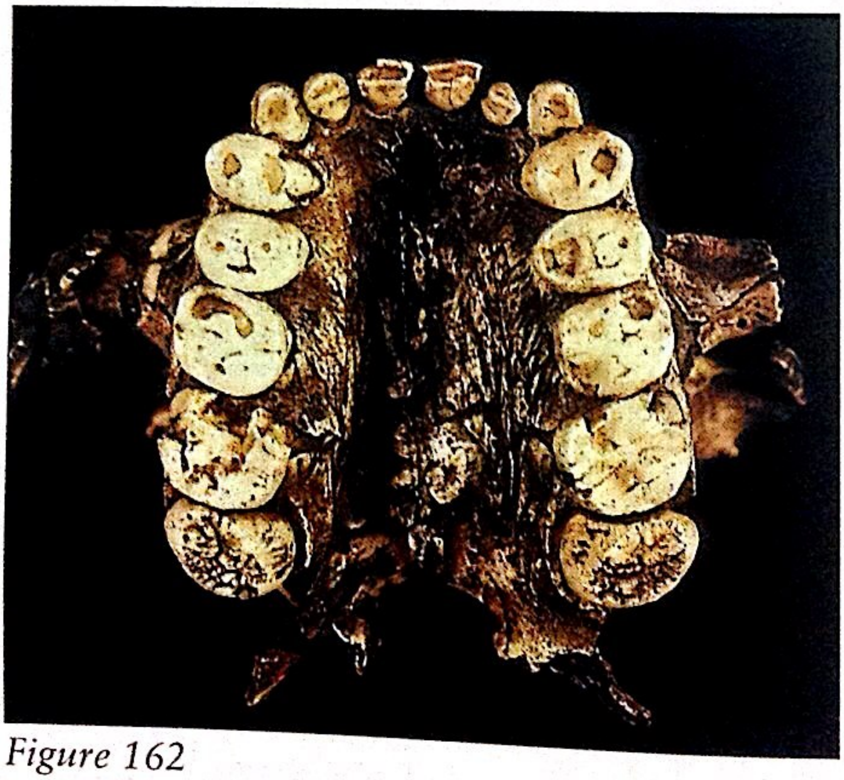


Figure 162

180 Identify this fossil ape. *(Figure 162)*

181 *(Figure 163)*

(a) Identify the species of this fossil skull.

(b) When did the species live?

(c) What was its cranial capacity?

(d) Did the mandible have a chin?

(e) Describe some of the differences between the dentition of this fossil and those of modern man.

(f) What is the name given to describe the general shape of the molar teeth show in *Figure 164* and sectioned longitudinally in *Figure 165*?

Figure 163

Figure 164

Figure 165

ANSWERS

The Mouth

1 (a) True. The palatoglossal folds and the palatopharyngeal folds are respectively the anterior and posterior pillars of the fauces at the oropharyngeal isthmus.
(b) True. Clinically, this communication permits the passage of liquid foods when the teeth are 'wired' together as treatment following fractures of the jaws.
(c) True. Hyperkeratinisation is a common reaction of the oral mucosa to trauma.
(d) True. The opening of the parotid duct may present as a papilla or as a simple opening into the cheek.
(e) False. The soft palate is raised during swallowing by the combined actions of the levator and tensor veli palatini muscles.
(f) False. The submandibular ducts open into the region of the sublingual papilla; the sublingual ducts open along the sublingual folds.
(g) False. Waldeyer's tonsillar ring 'guarding' the openings of the pharynx also includes the tubal and pharyngeal tonsils in the nasopharynx.
(h) False. The lingual frenum usually ends at the sublingual papilla.
(i) False. The anterior part (palatal part) occupies two-thirds of the dorsum of the tongue.
(j) False. The foramen caecum is the site of development of the thyroid gland. The thymus gland develops from the third pharyngeal (branchial) pouch.

2 (a) A = incisive papilla. B = palatine raphe. C = palatine rugae. D = soft tissue masses where greater palatine nerves and vessels run.
(b) The mucosa over the hard palate has a keratinised (masticatory) stratified squamous epithelium. For most parts, there is no submucosa and the tissue presents as a mucoperiosteum.
(c) The nasopalatine nerves exit at the incisive fossa and are thus located below the incisive papilla and behind the maxillary central incisor teeth. The greater palatine nerves run in a submucosa, each along a lateral channel between the maxillary alveolar and the maxillary palatine processes.
(d) The mucoperiosteum is an effective barrier to the spread of infection from the maxillary teeth into the hard palate. Therefore, palatal abscesses tend to be discrete and well-defined.

3 (a) A = lingual frenum. B = fimbriated fold. C = deep lingual vein. D = sublingual papilla. E = sublingual folds.
(b) The structure labelled D, the sublingual papilla, has the submandibular ducts (Wharton's ducts) opening onto it. The structure labelled E, the sublingual fold, indicates the position of the sublingual salivary gland and the course of the submandibular duct.
(c) The mucosa lining the ventral surface of the tongue has a non-keratinised (lining) stratified squamous epithelium.
(d) A sublingual abscess, located above the mylohyoid muscle in the floor of the mouth, may spread to become a submandibular abscess in the suprahyoid region of the neck by passing around the posterior free edge of the mylohyoid muscle. Only rarely would the infection pass through the mylohyoid muscle.

4 (a) The patches are termed 'Fordyce spots' and they are ectopic sebaceous glands (structures normally restricted to the skin).
(b) Developmentally, the mouth is a region where both ectoderm and endoderm make contributions.
(c) Hormonal changes at puberty can stimulate the formation and secretion of sebaceous glands.

The Jaws

5 (a) True. The skull is divided into viscerocranium and neurocranium (the latter being the part which houses and protects the brain and the organs of special sense).
(b) True. However, whilst the statement is correct as far as it goes, do not forget that there are other components (eg the orbital plate).
(c) False. The infra-orbital nerve is the terminal branch of the maxillary division of the trigeminal nerve.
(d) False. The greater palatine foramen is really a fissure at the lateral extremity of the transverse palatine sutured where the palatine process of the maxilla joins the horizontal plate of the palatine bone. The lesser palatine foramen is located in the palatine bone.
(e) False. The condylar process is located supero-posteriorly on the ramus; the coronoid process is supero-anteriorly.
(f) False. In Caucasians, the mental foramen is most often located below the root of the mandibular second premolar. In some other races, the foramen may be positioned more distally.
(g) False. The genial tubercles give origin to the genioglossus and geniohyoid muscles. The digastric muscles are attached into the digastric fossae on the inferior border of the mandible.
(h) False. On a lateral skull radiograph, the maxillary sinus can be visualised but there is much super-imposition of structures.
(i) True. TMJ radiography too readily distorts the morphology of the condyle to provide an accurate assessment of its dimensions or pathologies. Tomography and computer-assisted scanning provide better assessments.
(j) False. The cortical bone lining the tooth socket is normally mineralised and not hypermineralised.

6 (a) A = palatine processes of the maxillae. B = horizontal plates of the palatine bones. C = median palatine suture. D = incisive fossa. E = transverse palatine suture. F = greater palatine foramina. G = lesser palatine foramina. H = posterior nasal spine.
(b) The maxillary plane can be represented by a line passing through the anterior nasal spine and the posterior nasal spine.
(c) At D, the incisive fossa, emerge the nasopalatine nerves which are branches of the maxillary division of the trigeminal via the pterygopalatine ganglion. At F, the greater palatine foramen, emerge the greater palatine nerves, also from the maxillary division of the trigeminal. At G, the lesser palatine foramen, emerge the lesser palatine nerves for the soft palate, again from the maxillary nerve.

7 (a) A = genial (mental) spines (tubercles). B = mylohyoid (internal oblique) ridge. C = angle of mandible. D = temporal crest. E = retromolar triangle. F = mandibular foramen. G = lingula. H = mylohyoid groove. I = digastric fossa. J = coronoid process. K = condylar process.
(b) At G, the lingula, is attached the sphenomandibular ligament (an accessory ligament of the temporomandibular joint). This ligament is the remains of the perichondrium of Meckel's cartilage (the cartilage of the first branchial arch).
(c) At A, the genial spines, are attached the genioglossus muscles (superior spines) and geniohyoid muscles (inferior spines). At B, the mylohyoid ridge, is attached the mylohyoid muscle which contributes to the diaphragm for the floor of the mouth. At C, the inner aspect of the angle of the mandible, is attached the medial pterygoid muscle. At D, the temporal crest, is attached (in part) the temporalis muscle. At I, the digastric fossa, is attached the anterior belly of the digastric muscle.
(d) The lingual branch of the mandibular nerve runs on the lingual alveolar plate of the permanent mandibular third molar tooth and must therefore be protected during surgical

extraction of this tooth. If the nerve is damaged, there will be: (i) loss of general sensation to the tongue (ventral and dorsal surfaces), floor of mouth, and lingual gingivae; (ii) loss of special sensation (taste) to the anterior two thirds of the tongue; and (iii) loss of secretomotor supply to the submandibular and sublingual salivary glands. The losses associated with (ii) and (iii) result from damage to the fibres from the chorda tympani branch of the facial nerve (nervus intermedius) which passes with the lingual nerve.

8 (a) Occipito-mental radiograph of the skull.
(b) A = Frontal air sinus. B = Margin of orbit. C = Nasal bones. D = Nasal septum. E = Nasal fossa with superimposed shadows of ethmoidal air cells. F = Maxilla and teeth. G = Body of mandible and teeth. H = Infra-orbital foramen and canal. I = Zygoma. J = Maxillary air sinus. K = Coronoid process of mandible. L = Zygomatic process of temporal bone. M = Condyle of mandible. N = Mastoid air cells. O = Occipital condyle. P = Foramen magnum.
(c) This radiograph is useful for obtaining clear views of the paranasal air sinuses; postero-anterior views of the skull (PA view) show too much supero-imposition of structures over the sinuses.
(d) The radiograph is of an anatomical specimen because of the absence of the vertebral column.

9 (a) The fracture is favourable. Behind the fracture line, the masseter and medial pterygoid muscles pull the jaw fragment upwards. In front of the fracture line, the digastric and other suprahyoid muscles pull the fragment downwards.
(b) Behind the condyle, in the infratemporal fossa, lie the meningeal branches (middle and accessory) of the maxillary artery. These are readily ruptured following fracture and inward displacement of the condyle.

10 (a) These structures are called tori mandibulares. Although not found in everyone's mouth, these exostoses are not strictly pathological and do not usually cause problems (occasional trauma of the mucosa can lead to subsequent ulceration and patient awareness of the tori).
(b) In the hard palate, where an occasional torus palatinus may be found. All tori may cause difficulties when constructing dentures.

11 Spacing is evident between the maxillary central incisors and is referred to as a diastema. Here, it is associated with the presence of a prominent labial frenum which can be surgically removed if the spacing persists. In younger children, spacing may be seen between the permanent incisors when they erupt, giving rise to what has been termed the 'ugly duckling' stage and is said to result from pressure on the roots of the incisors from the developing canines. In this situation, the diastema usually closes following eruption of the permanent canines. There is also a slight shift of the midline in the lower dentition.

Tooth Morphology

12 (a) False. It is the maxillary lateral permanent incisor that presents the pit (foramen caecum).
(b) False. The convexity lies at the junction of the incisal edge with the distal surface.
(c) False. A pulp horn is not found beneath the small distal cusp.
(d) False. The tip of the palatal cusp is generally displaced towards the mesial surface of the crown.
(e) False. The obtuse angles of this tooth are the mesiopalatal and the distobuccal.
(f) False. It is the mesial root that possesses two root canals.
(g) False. The maxillary third permanent molar [illegible] as it tends to be angled

distally. It is the mandibular third molar that is most commonly impacted, being angled mesially.
(h) False. The roots of the mandibular deciduous incisors have a rounded outline.
(i) False. The bulge (molar tubercle) lies near the cervical margin above the mesial root.
(j) False. A cusp of Carabelli is found frequently on this tooth, just as in the maxillary first permanent molar.

13 The notched incisal margin, containing three mammelons, is normal in the recently erupted tooth, but is lost with attrition.

14 Yes, the tooth has two roots instead of its usual single root. This may be clinically significant during endodontic treatment or tooth extraction.

15 The wide open pulp and the smooth, thin lining of dentine indicate that the root is incomplete and still forming.

16 (a) Maxillary left lateral permanent incisor. Palatal view.
(b) 10 – 12 months.
(c) 8 – 9 years.
(d) Anterior superior alveolar nerve, infra-orbital nerve, nasopalatine nerve.

17 (a) Maxillary left permanent canine. Labial view.
(b) 4 – 5 months.
(c) 11 – 12 years.

18 (a) Maxillary right first premolar. Occlusal view.
(b) $1^1/_2$ – 2 years.
(c) 10 – 11 years.

19 (a) Mandibular right first premolar. Lingual view.
(b) $1^1/_2$ – 2 years.
(c) 10 – 12 years.
(d) Inferior alveolar nerve, mental nerve, (possibly the buccal nerve), lingual nerve.

20 (a) Maxillary left first permanent molar. Palatal view.
(b) Birth.
(c) 6 – 7 years.
(d) Posterior and middle superior alveolar nerves, buccal nerve, greater palatine nerve.

21 (a) Mandibular right second permanent molar. Buccal view.
(b) $2^1/_2$– 3 years.
(c) 12 – 13 years.
(d) Inferior alveolar nerve, buccal nerve, lingual nerve.

22 (a) Maxillary left central deciduous incisor. Labial view.
(b) 4 months *in utero*.
(c) 7 months.

23 (a) Maxillary left first deciduous molar. Occlusal view.
(b) 5 months *in utero*.
(c) 1 – $1^1/_2$ years.

24 (a) Mandibular left second deciduous molar. Buccal view.
(b) 6 months *in utero*.
(c) $1^3/_4$ – $2^3/_4$ years.

25 Structure A represents a supernumerary tooth which has erupted into the palate behind the permanent incisors. The supernumerary tooth usually has a simplified cone-shaped form. It most commonly occurs in this region, when it is called a mesiodens. It may remain unerupted and be discovered on a radiograph when the patient presents with delayed eruption of the permanent maxillary incisor(s).

26 Yes. As evident from the fully erupted first permanent molars, the patient is about 9 years of age. However, all the remaining permanent teeth have failed to develop and the deciduous dentition has been completely retained.

Occlusion

27 (a) False. The dental arches are shaped as a catenary curve; rectangular forms are associated more with apes.
(b) False. Seen laterally, the curvature of the occlusal plane is termed the curve of Spee. The curve of Monson (more correctly, the curve of Wilson) is seen transversely, across the dental arch.
(c) False. Malocclusion is most prevalent in the community. 'Normal' occlusion is found in only about 10% of the population (USA data).
(d) True. Centric occlusal position is the standard occlusal position to assess the 'bite' of a patient. However, it is all too frequently difficult to achieve; palpation of the condyles in the glenoid (mandibular) fossae might aid the attainment of centric occlusal position.
(e) False. In the 'normal' (or anatomical) occlusal position, a maxillary tooth will occlude with the distal portion of the corresponding mandibular tooth plus the mesial portion of the mandibular tooth distally.
(f) False. Although the permanent maxillary canines are indeed frequently malaligned, the maxillary incisors are more often in malocclusion.
(g) True. This landmark, together with the supramentale associated with the mandible, is used for cephalometric assessment of the relationships of the jaws during orthodontic diagnosis.
(h) False. The Frankfort plane, being a useful guide to the line of the maxilla, extends from the Porion to the orbitale.
(i) False. The 'normal' angle is 110°; 90° is the angle between the axes of the mandibular incisors and the mandibular plane.
(j) False. SÑA – SÑB for a normal (skeletal Class I) jaw relationship is 2 – 5°. Below 2° the relationship is Class III and the mandible shows prognathism. A Class II relationship (above 5°) shows maxillary prognathism.

28 (a) A = Nasion. B = Sella point. C = Porion. D = Orbitale. E = Basion. F = Posterior nasal spine. G = Anterior nasal spine. H = Subspinale. I = Supramentale. J = Pogonion. K = Gnathion. L = Menton. M = Gonion.
(b) Cephalometric radiographs for a dental patient are most often taken to assess jaw relationships during orthodontic diagnosis and to determine the extent and nature of growth of the facial skeleton.
(c) A = The Bolton plane (ie Bolton point to Nasion). B = Sella–Nasion plane (ie Sella point to Nasion).

29 Angle's Class III malocclusion—the first permanent molars almost have a cusp-to-cusp relationship (the mandibular molars being 'prenormal' relative to the maxillary molars). Note that the reverse overjet for the incisors is not necessary indicative of an Angle's Class III malocclusion (there may be a normal overjet or edge-to-edge bite).

30 (a) In terms of the incisor classification of occlusion, the malocclusion is designated Class II division 1—the tip of the mandibular incisors lying behind the cingulum of the maxillary incisors which themselves show marked proclination.
(b) Angle's classification, using the position of the permanent first molar teeth, may be affected by movement of these teeth in response to loss of other teeth in the arches or, being the first of the permanent teeth to erupt into the mouth, they may themselves be lost because of dental caries. Furthermore, patients are more likely to come to the orthodontist complaining of 'unsightly' malposition of their anterior teeth than about malposition of their molars.

31 The lower incisors overlap the upper incisors, giving a reverse overjet. This indicates a Class III incisor relationship (the Angle's molar relationship cannot be determined from this anterior view). In addition, the width of the lower arch is greater than that of the upper, resulting in a crossbite in the molar region. Note also that the midlines of the upper and lower jaws do not coincide exactly.

32 This patient has an anterior open bite, the lower incisors not being overlapped by the uppers. It may be associated with an an anterior tongue thrust on swallowing, or the patient may be an habitual thumb sucker. It may also be associated with an abnormal, and premature, occlusal contact on the posterior teeth. More rarely, it is related to underdevelopment of the upper anterior segment of the jaw.

Floor of Mouth and Tongue

33 (a) False. The mylohyoid muscle takes origin from the internal oblique (mylohyoid) line of the mandible.
(b) False. Whilst the deep part of the submandibular gland and the hypoglossal nerve are located superficial to the hyoglossus muscle, the glossopharyngeal nerve runs deep to the muscle.
(c) True. In addition, the lingual nerve supplies the lingual gingivae around the mandibular teeth.
(d) False. There is no sublingual group of lymph nodes; the lymphatic drainage of structures in the floor of the mouth is to the submental nodes (or even directly to the jugulo-digastric nodes).
(e) False. The submandibular ganglion, supplying secretomotor fibres to the submandibular and sublingual salivary glands, receives preganglionic fibres from the chorda tympani branch of the facial nerve (nervus intermedius).
(f) True. The papillae found are filiform, fungiform, circumvallate (largest) and foliate papillae. On the posterior third of the dorsal surface are found the lingual follicles (lymphatic tissue).
(g) False. The intrinsic muscles alter the shape of the tongue; the extrinsic muscles (genioglossus, hyoglossus, palatoglossus, styloglossus) alter the position of the tongue in the mouth.
(h) True. Palatoglossus, being also classified as a muscle of the soft palate, is innervated by the cranial part of the accessory nerve via the pharyngeal plexus.
(i) False. The lingual artery runs deep to the hyoglossus muscle.
(j) False. The anterior part of the sublingual gland has a main duct (Bartholin's duct) which either drains directly onto the sublingual papilla or joins the submandibular duct. The posterior part of the gland has many small ducts draining into the floor of the mouth in the region of the sublingual fold.

34 (a) A = hard palate. B = soft palate. C = orbicularis oris in upper lip. D = edentulous maxillary alveolar ridge. E = pillars of fauces. F = nasopharynx. G = oropharynx. H = laryngopharynx. I = constrictor muscles of pharynx. J = vertebral column. K = orbicularis

oris in lower lip. L = body of mandible. M = tongue. N = genioglossus muscle.
O = geniohyoid muscle. P = mylohyoid muscle. Q = anterior belly of digastric muscle.
R = platysma muscle. S = hyoid bone. T = epiglottis. U = vallecula.

(b) The genioglossus muscle (label N) is innervated by the twelfth cranial nerve (the hypoglossal nerve). The geniohyoid muscle (label O) is innervated by the fibres from the first cervical spinal nerve which accompany the hypoglossal nerve. The mylohyoid muscle (label P) is innervated by the fifth cranial nerve (the mandibular division of the trigeminal nerve). The anterior belly of the digastric muscle (label Q) is innervated by the fifth cranial nerve (the mandibular division of the trigeminal nerve). The posterior belly of digastric is supplied by the seventh cranial nerve (the facial nerve).

(c) Structure N, the genioglossus muscle, protrudes the tongue.

(d) The median and lateral glosso-epiglottic folds delineate the vallecula. Clinically, foreign objects may become lodged in this region.

(e) Although the lingual nerves supply general sensation to much of the dorsum of the tongue and all of the ventral surface, there are other innervations and the position of the tongue also is 'monitored' by receptors in other oral structures. To bring the tongue forward in an unconscious patient, the mandible must be pulled forwards by pressure applied on both sides at the angle of the mandible.

35 (a) A = tongue. B = lingual nerve. C = styloglossus muscle. D = hyoglossus muscle.
E = outline of deep part of the submandibular salivary gland. F = sublingual salivary gland.
G = submandibular duct. H = hypoglossal nerve. I = nerve to thyrohyoid muscle.
J = descendens hypoglossi. K = lingual artery.

(b) Structure J, the descendens hypoglossi, communicates with the ansa cervicalis nerve plexus in the neck. Damage to the descendens hypoglossi would result in partial paralysis of strap (infrahyoid) muscles.

(c) The submandibular salivary gland secretes mixed mucous-serous saliva. The serous acini are much more numerous than the mucous acini (10:1). The sublingual salivary gland also produces a mixed saliva, but with more mucous than serous elements. On occasions, both glands are fused to form a submandibular/sublingual salivary complex.

(d) A retention cyst from the sublingual gland can extend into the neck by expanding across the posterior free edge of the mylohyoid muscle and into the suprahyoid region of the neck.

36 The distribution of sensory nerves to the dorsum of the tongue can be readily explained in terms of the development of the tongue. The tongue in front of the circumvallate papillae (A) is derived from the first pharyngeal (branchial) arch, the nerve of this arch being the mandibular division of the trigeminal (and hence its lingual branch). Behind the circumvallate papillae, the third pharyngeal (branchial) arch (associated with the glossopharyngeal nerve - B) and fourth pharyngeal (branchial) arch (associated with the superior laryngeal branch of the vagus - C) are responsible for forming the posterior third of the organ. Taste receptors anteriorly are innervated by the chorda tympani branch of the facial nerve, the nerve of the second pharyngeal (branchial) arch. Since this arch does not contribute tissue to the anterior part of the tongue, in this situation the chorda tympani nerve is termed a pretrematic nerve.

37 The picture shows a 'tongue-tie'. Normally, the lingual frenum terminates on the sublingual papilla. Here, the frenum extends across the floor of the mouth to become attached to the lingual alveolus behind the mandibular incisors. Tongue-tie may severely limit movements of the tongue and could affect speech.

38 The deviation of the tongue to the right indicates that the right hypoglossal nerve (CN XII) was damaged during surgery, the action of the extrinsic muscles on the left side being unopposed. There has also been wasting of the muscles on the right side of the tongue.

Palate

39 (a) False. The components of the palate develop intramembranously.
(b) False. The fibrous aponeurosis is the expanded tendon of the tensor veli palatini muscle.
(c) False. The exception is tensor veli palatini (which develops embryologically from the first pharyngeal (branchial) arch and is therefore supplied by the mandibular nerve.
(d) True, an additional origin being from the cartilage of the auditory (Eustachian) tube.
(e) False. This suture does not occur in humans (but does occur in apes).
(f) True. In this position, it is accompanied by the cartilaginous end of the auditory (Eustachian) tube.
(g) False. The pyramidal process is part of the palatine bone.
(h) True. The presence of this suture allows for the possibility of expanding the width of the palate with appliances when the palate is unusually narrow.
(i) True. The nerves are distributed via the pterygopalatine ganglion.
(j) True. The two heads of origin enclose the levator veli palatini muscle.

40 (a) A = palatoglossal arch (anterior pillar of fauces). B = palatopharyngeal arch (posterior pillar of fauces). C = palatine tonsil. D = uvula. E = soft palate. F = ridge produced by pterygomandibular raphe.
(b) Much of the mucosa is innervated by the lesser palatine nerves which originate from the maxillary division of the trigeminal nerve (via the pterygopalatine ganglion). Some areas may also be innervated by the facial nerve. The posterior part of the soft palate (including uvula) and the region of the pillars of the fauces are innervated by the glossopharyngeal nerve.

41 This is a section through the palate.
(a) A = respiratory mucosa of nasal cavity. B = lining mucosa (non-keratinised) of soft palate. C = masticatory mucosa (keratinised or parakeratinised) of hard palate.
(b) D = levator veli palatini muscle.
(c) The region of the hard palate immediately behind the incisor teeth and near the incisive papilla contains the fibres of the nasopalatine nerve to be anaesthetised. However, there is no submucosa, the oral mucosa being tightly bound down to the underlying bone by a mucoperiosteum. The region can only accommodate a small amount of local anaesthesis solution, which is all that is necessary. The amount of anaesthetic solution and the speed of injection have probably detached part of the mucosa from the bone, resulting in the considerable after pain.

42 This structure represents a remnant of the epithelial seam in the midline region of the developing palate originally separating the palatal shelves. Such epithelium remnants may enlarge and give rise to palatal cysts.

Face

43 (a) True. This would explain why, following nerve damage on the face, the area affected is well-circumscribed and does not cross the midline.
(b) False. The infra-orbital nerve supplies the whole of the upper lip, including the philtrum.
(c) False. The muscle arises below the mental foramen.
(d) False. The parotid gland derives its secretomotor fibres from the glossopharyngeal nerve.
(e) True. The infra-orbital nerve can be 'blocked' as it emerges onto the face, but care is needed to locate the infra-orbital foramen to avoid pushing the needle into the orbit.
(f) False. The parotid duct lies below the transverse facial artery.
(g) True. This provides a pressure point to compress a damaged facial artery to prevent haemorrhage.

(h) False. On the face, the facial vein lies behind the facial artery.
(i) True. The parent nerve is the nasociliary branch of the ophthalmic division of the trigeminal.
(j) True. The remaining origin is from the alveolar processes of the maxilla and mandible adjacent to the molar teeth.

44 (a) The lymphatic drainage of the side of the face (A) is to the parotid lymph nodes, of the upper lip (B) to the submandibular lymph nodes, and of the central part of the lower lip (C) to the submental lymph nodes. The arterial supply to the side of the face is mainly from branches of the superficial temporal artery, and to the upper and lower lip from the superior and inferior labial branches of the facial artery.
(b) A = supra-orbital nerve. B = auriculotemporal nerve. C = external nasal nerve. D = zygomaticotemporal nerve. E = mental nerve. F = great auricular nerve.

45 (a) A = orbicularis oculi (orbital part). Temporal and zygomatic branches of facial nerve. B = levator labii superioris. Zygomatic and buccal branches of facial nerve. C = zygomaticus major. Zygomatic and buccal branches of facial nerve. D = levator anguli oris. Zygomatic and buccal branches of facial nerve. E = depressor labii inferioris. Mandibular branch of facial nerve. F = depressor anguli oris. Buccal and mandibular branches of facial nerve. G = platysma. Cervical branch of facial nerve.
(b) H = superficial temporal artery. I = parotid duct. J = facial artery. K = branch of facial nerve. L = great auricular nerve. M = external jugular vein.
(c) The structure labelled N is the facial vein. It has important connections with the cavernous sinus within the cranial cavity. Near the corner of the eye, the facial vein (angular vein) communicates with the superior ophthalmic vein. The ophthalmic vein drains directly into the cavernous sinus. As the facial vein has no valves, infection is able to spread along the ophthalmic veins and into the cavernous sinus with serious consequences. The facial vein is also connected to the pterygoid venous plexus via the deep facial vein, the pterygoid venous plexus being connected to the cavernous sinus through emissary veins.

46 The patient has Bell's palsy, which affects the facial nerve and consequently the muscles of facial expression. In the absence of obvious trauma or a tumour of the parotid gland, the aetiology of this condition is unknown, although it is commonly associated with being in a cold or draughty environment. A hemiparalysis of the muscles of facial expression leads to a loss of the normal creases and folds in the face on the affected side. This gives the face an almost expressionless (death mask) appearance. Paralysis of the muscles associated with the cheek and lips was responsible for the inability to smile, whistle or eat properly. The loss of action of the orbicularis oculi muscle and the absence of blinking can render the conjunctiva and cornea susceptible to inflammation and may eventually lead to blindness if untreated.
A facial palsy can also result from a brain lesion. Where only the lower half of the face is affected, a lesion in the contralateral side of the brain above the facial nucleus in the pons is indicated, as the upper half of the face has some ipsilateral as well as contralateral representation.

47 The dentures have been constructed without giving the patient adequate freeway space (i.e. the few millimetres between the occlusal surfaces of the teeth with the mandible in the rest position). This produces an 'over-opened' position. The result is an elongation of the face, a parting of the lips at rest, and a 'strained' facial appearance. The patient is likely to experience difficulty in speaking, with the teeth making premature contact with certain syllables (e.g. the letter 's').
If a denture is constructed with too much freeway space, the patient will have an 'over-closed' appearance, with a closer approximation of the nose and chin than normal. The greater the degree of over-closure, the more the soft tissues of the face appear to sag and fall in, and the more pronounced are the lines on the face.

Deep Face (infratemporal fossa)

48 (a) True. It is thus a region of considerable importance to the dental surgeon, containing the mandibular nerve, the maxillary artery, the otic ganglion, the pterygoid muscles, and the pterygoid venous plexus.
(b) True. This explains the possibility of the rapid spread of infection from the infratemporal fossa into the neck.
(c) False. The infratemporal and pterygopalatine fossae communicate through the pterygomaxillary fissure (a fissure between the pterygoid plates of the sphenoid bone and the tuberosity of the maxilla).
(d) False. The deep temporal artery is a branch of the second part of the maxillary artery. Note that the first part lies before the lateral pterygoid muscle (having branches all of which enter bony canals) and the second part lies on (or behind) the pterygoid muscle (having branches going to soft tissues, including the muscles of mastication).
(e) True. Connections between the intracranial and extracranial venous systems are termed emissary veins.
(f) False. The inferior alveolar nerve is derived from the posterior trunk of the mandibular nerve. The anterior trunk is essentially motor (excepting the buccal nerve) and the posterior trunk is mainly sensory (excepting the mylohyoid nerve).
(g) True. This relationship is important when inserting a needle into the infratemporal fossa for the local anaesthesia of nerves supplying dental structures.
(h) True. The preganglionic fibres are derived from the lesser petrosal branch of the glossopharyngeal nerve. Postganglionic fibres pass with the auriculotemporal branch of the mandibular nerve to the parotid gland.
(i) False. The lower head is derived from the lateral pterygoid plate. The upper head originates from the sphenoid bone in the roof of the infratemporal fossa.
(j) False. The medial pterygoid muscle is inserted into the angle of the mandible. The muscle's main site of origin is the medial side of the lateral pterygoid plate of the sphenoid bone.

49 (a) A = ramus of mandible. B = back of maxilla. C = buccinator muscle. D = lateral pterygoid muscle. E = medial pterygoid muscle. F = inferior alveolar nerve. G = lingual nerve.
(b) The boundaries of the infratemporal fossa are:
anteriorly—the posterior surface of the maxilla.
posteriorly—styloid apparatus, carotid sheath and deep part of parotid gland.
laterally—the ramus of the mandible.
medially—the lateral pterygoid plate and superior constrictor muscle of the pharynx.
The roof of the infratemporal fossa is formed by the infratemporal surface of the greater wing of the sphenoid. There is no anatomical floor.
(c) The lateral pterygoid muscle is involved in depression, protrusion and lateral (side-to-side) movements of the mandible.
The medial pterygoid muscle is essentially an elevator of the mandible. It is also involved in protrusion and side-to-side movements of the lower jaw.
(d) The infratemporal fossa communicates with the orbit near the pterygopalatine fossa by way of the inferior orbital fissure. Very rarely, visual defects may also follow the administration of an inferior alveolar nerve block as a result of vascular spasm. For example, the orbit in some people may be supplied by the middle meningeal artery. Fortunately, these visual complications are transient, passing off with the disappearance of anaesthesia.

50 (a) High. Note the condyle of the mandible (A) and the lateral pterygoid muscle (B) which are located in the roof of the infratemporal fossa.

(b) A = condyle of mandible. B = lateral pterygoid muscle. C = coronoid process of mandible. D = masseter muscle. E = temporalis muscle. F = zygomatic arch. G = maxillary air sinus. H = opening of maxillary sinus into middle meatus.

51 (a) Middle. Note the bulk of the masseter (B) and medial pterygoid (C) muscles around the ramus of the mandible (A) and the absence of the lateral pterygoid muscle.
(b) A = ramus of mandible. B = masseter muscle. C = medial pterygoid muscle. D = styloid group of muscles. E = parotid gland. F = buccinator muscle. G = internal carotid artery and internal jugular vein.

52 Difficulty in opening the jaws because of muscle spasm is called trismus. In this case, the medial pterygoid muscle is affected as a result of damage associated with the injection. The onset of trismus often occurs some time after the injection and thus can be distinguished from the general soreness and discomfort that may be experienced immediately after dental treatment. Trismus is usually caused by bleeding into the muscle (as a result of damage to blood vessels) or infection. The term haematoma is used to describe a localised mass of extravasated blood. In view of the highly vascular nature of the infratemporal fossa, particularly because of the many vessels of the pterygoid venous plexus, it is not unusual for haematomas to form in this region. Bleeding from the pterygoid venous plexus may produce a rapid and dramatic swelling in the region of the cheek and discolouration or bruising of the skin. However, bleeding into the pterygomandibular space may not be immediately apparent.
Note that, because of the prominence of the veins and the position of the maxillary artery towards the roof of the infratemporal fossa, injections producing haematomas rarely result from involvement of the artery. In the present case, the haematoma associated with the trismus has become infected and this is potentially life-threatening, not only because of direct spread to other regions around the jaws and the neck, but also via the emissary veins which link the pterygoid venous plexus with the cavernous sinus intracranially (via the foramen ovale, foramen spinosum and sphenoidal emissary foramen).

53 The inferior alveolar nerve in the infratemporal fossa lies close to the sphenomandibular ligament and behind the posterior edge of the medial pterygoid muscle. It enters the mandible through the mandibular foramen, a foramen situated approximately half-way up the vertical dimension of the ramus of the mandible (and hence the infratemporal fossa). Thus, to approach the nerve directly for local anaesthesia would involve placing the needle through the medial pterygoid muscle. Furthermore, because of the lateral 'flanging' of the ramus relative to the line of the body of the mandible, an indirect, two-staged approach to the inferior alveolar nerve not only avoids the medial pterygoid muscle but also allows the hypodermic needle to pass easily around the protecting 'buttress' of bone produced by the ramus's angulation.

Temporomandibular Joint and Muscles of Mastication

54 (a) False. The upper joint cavity is associated with forward translocatory movements of the mandible.
(b) True, the clefts forming the upper and lower joint cavities being evident at this time.
(c) False. The attachment is to the lateral pterygoid muscle.
(d) False. As the forming the articular surfaces develop intramembranously, the articular surfaces are lined by fibrous tissue.
(e) False. As the load impinging on the condyle is small, the bone of the mandibular fossa is thin.
(f) False. The digastric muscle depresses and retracts the mandible.
(g) False. The buccal branch of the mandibular nerve passes between the two heads of the lateral

pterygoid muscle.
(h) True, the two heads being referred to as the superficial and deep heads.
(i) True. The parotid duct bends sharply at the anterior border of the muscle to penetrate the underlying buccinator muscle.
(j) False. The attachment of the temporalis muscle is limited by the inferior temporal line, the superior temporal line giving origin to the temporal fascia.
(k) False. The auriculotemporal (and masseteric) nerve supplies the main sensory component.
(l) True. Otherwise, the chorda tympani nerve would lie within the capsule.
(m) False. The nerve to the medial ptrygoid arises before the division of the mandibular nerve.
(n) True. Hence their supply by the nerve of the first pharyngeal arch, the mandibular nerve.
(o) True. The disc may then be regarded as fibrocartilaginous.
(p) True. The other movements (ie opening, closing, protraction, retraction) are symmetrical.
(q) False. Only the anterior belly is supplied by the mandibular nerve, the posterior belly is supplied by the facial nerve.
(r) True. Internal derangement of the disc may result in the disc being displaced anteromedially with respect to the joint surfaces.
(s) True. This allows the muscle to increase its power.
(t) False. This ligament is found laterally.

55 (a) A = masseter (masseteric branch of anterior division of mandibular nerve). B = temporalis (deep temporal branches of anterior division of mandibular nerve). C = posterior belly of digastric (facial nerve). D = platysma (cervical branch of facial nerve).
(b) E = temporal fascia. F = styloid process. G = spinal accessory nerve. H = hypoglossal nerve and descendens hypoglossi.

56 A = articular disc. B = mandibular fossa. C = condyle of mandible. D = capsule of joint. E = lateral pterygoid muscle. F = articular eminence.

57 A = articular disc. B = lower joint space. C = fibrous layer covering articular surface. D = cell rich layer of proliferative zone. E = layer of fibrocartilage. F = layer of calcified cartilage. G = bone of condylar cartilage.

58 This is a section taken through the condylar region of a child as, compared with figure 51 which is taken from an adult jaw, the secondary condylar cartilage is still evident. This cartilage disappears at approximately the age of 15 years.

59 The patient has suffered a dislocation of the temporomandibular joint. As the chin has deviated towards the left side, the dislocation is unilateral, affecting the joint on the right side. The right mandibular condyle and articular disc have become displaced anterior and superior to the lowest point of the articular eminence of the temporal bone. Clinical examination may reveal a depression immediately in front of the tragus. The displacement of the condyle is confirmed by the radiographs. If the dislocation was bilateral, the mouth would be wide open with the chin positioned centrally. The condition is associated with wide-open mouth procedures and may arise following a yawn or even on dental flossing.

60 The signs are compatible with a unilateral fracture of the left mandibular condyle (as confirmed by the radiograph). The bleeding may be the result of damage to the external acoustic meatus. The premature contact of the teeth on the left side is due to the displacement of the left mandibular condyle and the resulting loss in height of the left ramus. The jaw deviates to the left on opening because of the unopposed activity of the unaffected right lateral pterygoid muscle. The diagnosis can be confirmed by radiography. About 30% of all mandibular fractures involve the condyles and occur in the region of the narrow neck.

Tissue Spaces Around the Jaws

61 (a) True. Tissue spaces transform from potential spaces into these spaces with the passage of pathologies such as oedema, pus, blood or tumours.
(b) False. Although many of the tissue spaces elsewhere in the body are defined by membranous fascia, most of the spaces around the jaws are defined by the jaws themselves and the muscles attached to them.
(c) True. In and around the ramus of the mandible are found the submasseteric, pterygomandibular, pharyngeal, buccal and parotid 'spaces'.
(d) True. The buccal space is also defined by the buccinator muscle.
(e) True. Between the medial pterygoid muscle and the ramus of the mandible lies the pterygomandibular space (in which lies the inferior alveolar and lingual nerves and accompanying vessels). Between the pterygoid muscle and the superior constrictor muscle lies the upper end of the parapharyngeal and retropharyngeal spaces.
(f) True. The intrapharyngeal space lies between the constrictor muscles and the internal mucosa. Infection around the tonsillar space is known clinically as quinsy.
(g) True. The submandibular space is demarcated by the anterior and posterior bellies of the digastric muscle. The submental space lies immediately below the chin and is bounded by the anterior bellies of the two digastric muscles.
(h) False. The palatine space is restricted by the mucoperiosteum of the hard palate, there being little submucosa.
(i) True. The upper parts of the parapharyngeal and retropharyngeal spaces lie in the region of the infratemporal fossa. This fossa has no floor and therefore communicates directly with the tissue spaces in the neck.
(j) True. The pterygoid venous plexus extracranially communicates with the cavernous sinus intracranially, providing a route for the spread of infection through the venous system (thrombophlebitis).

62 (a) A = sublingual space. B = submandibular space. C = buccal vestibule. D = buccal space. E = submasseteric space(s). F = pterygomandibular space. G = parapharyngeal space. H = peritonsillar space.
(b) Label E indicates the submasseteric space(s). This region does not present as a single, discrete space because of the mode of attachment of the muscle down almost the entire lateral surface of the ramus of the mandible. Consequently, infection spreading into this 'labyrinth' of spaces is difficult to drain.

63 (a) A = Cleft between genioglossus and hyoglossus muscles communicating directly with parapharyngeal space. B = Sublingual space between hyoglossus and mylohyoid muscles. C = Submandibular space below the mylohyoid muscle.
(b) The sublingual and submandibular spaces communicate directly around the posterior free edge of the mylohyoid muscles. Thus, a sublingual abscess can readily spread around the mylohyoid to become a submandibular abscess.
(c) The tissue space labelled C is the submandibular space. This is bounded inferiorly by the attachment of the investing layer of deep cervical fascia to the hyoid bone, thus explaining the fact that spread of infection from the submandibular space to the lower regions of the neck must involve a backward passage into the parapharyngeal region. Continued accumulation of the products of infection in the submandibular, submental and sublingual spaces (on both sides) will produce a marked swelling which, although restricted to this region, may be life-threatening because of the encroachment on the airway. This condition is known as Ludwig's angina.

64 A = buccal tissue space. B = vestibule of mouth, region of vestibular sulcus.

Both the buccal tissue space and the vestibular sulcus are bounded by the buccinator muscle. C = sublingual tissue space. D = submandibular tissue space. The sublingual and submandibular spaces are separated by the mylohyoid muscle in the floor of the mouth.

65 The spread of infection to the buccal region of the face indicates that the root apex of the affected tooth is situated above the attachment of the buccinator muscle onto the maxilla. Only rarely would infection from a tooth spread through the muscle and in such cases the infection is more likely to be restricted by this muscle to produce an abscess in the buccal vestibule of the mouth. Infections in the face can spread intracranially to the cavernous sinus by way of venous connections. The facial vein communicates with the superior ophthalmic vein and this drains directly into the cavernous sinus. As the facial vein has no valves, infection is able to spread along the ophthalmic veins to cause thrombosis in the cavernous sinus.

Enamel

66 (a) False. Enamel contains about 1% by weight of organic matrix, with 3% water.
(b) True. The width is about 70nm and the length is indeterminate.
(c) True. In a cross-section of pattern 3 enamel, the tail of a prism is seen to lie between the heads of two prisms in the row below.
(d) False. The presence of prisms in carefully demineralised sections may indicate regional variations in the organic matrix.
(e) False. The variation in prism direction is responsible for the Hunter–Schreger bands.
(f) True. The lower solubility of fluorapatite is the reason for giving fluoride tablets to children.
(g) False. Enamel matrix is heterogeneous, much being present as tuft protein at the enamel-dentine junction.
(h) False. There is little variation is prism diameters throughout enamel.
(i) True. Because of their orientation, they are most readily seen in longitudinal sections of enamel.
(j) False. Gnarled enamel is found beneath the cusps and incisal margins.
(k) True. Mineral salts include hydroxyapatite, amorphous calcium phosphate and crystalline octocalcium phosphate.
(l) True. Therefore in deciduous enamel less of the underlying yellow dentine shows through the enamel.
(m) False. Pattern 1 enamel displays circular prisms, and is most often located close to the enamel–dentine junction.
(n) False. In permanent teeth, the average thickness of enamel is 2.5mm.
(o) True. Enamel shows both intrinsic and form birifringence.
(p) False. They are present in the inner two-thirds of enamel where groups of prisms decussate.
(q) True. In developing enamel, the enamel matrix consists mainly of amelogenins.
(r) False. Enamel spindles project from the enamel–dentine junction.
(s) True. Before eruption, it is covered by Nasmyth's membrane; after eruption, by the acquired pellicle.
(t) True. The initial collagenous matrix is secreted by odontoblasts.

67 (a) A = Enamel striae (of Retzius).
(b) Longitudinal section, due to the oblique orientation of the enamel striae (in a cross-section they would be circularly arranged).
(c) A, as the enamel striae pass downwards and inwards from the enamel surface.

(d) The enamel striae are thought to represent an approximately seven day incremental feature.
(e) No. They lie closer together near the enamel–dentine junction and at the enamel surface where the daily increments of enamel are smaller.
(f) Perikyma occur where enamel striae reach the surface.
However, enamel striae do not reach the surface over the cusps and incisal margins.

68 (a) A = enamel tuft. B = enamel–dentine junction. C = enamel lamella.
(b) Transversely, as enamel tufts and lamellae are mainly seen in this plane of section.
(c) If C was an artifact (ie a crack), it would disappear if the section were demineralised. In a demineralised section the true enamel lamella would show its organic nature.
(d) Yes, as enamel tufts are hypomineralised areas of enamel.

69 (a) The lines indicated are those of the prism boundaries. The distance between prism boundaries is 5μm.
(b) Prism boundaries are seen because of sudden changes in crystallite orientation.
(c) Yes, all mammalian enamel is prismatic; reptilian enamel is aprismatic.
(d) At the light microscope level, prism boundaries are about 1μm thick, while with the electron microscope their thickness is barely measurable, being measured in terms of a few nanometres.
(e) Cross-striations.
(f) Cross-striations are not visible using the electron microscope. Their distance apart varies from about 2.5μm (near the enamel–dentine junction and the surface enamel) to about 5μm in the main body of enamel

70 (a) A = Aprismatic surface zone of enamel.
(b) Its lack of a prismatic structure as in the subsurface zone (B) relates to the absence of a Tomes process during its development.
(c) The aprismatic zone in deciduous teeth is said to be wider.
(d) Surface enamel is harder, less porous and less soluble than subsurface enamel. There are also chemical differences (eg surface enamel has more fluoride and less carbonate than subsurface enamel).
(e) Knowledge of etching patterns may help us understand the process of dental caries and clinical procedures such as the application of bonding materials and fissure sealants.

71 (a) The enamel prisms have been sectioned transversely.
(b) The keyhole type of arrangement of the enamel prisms in staggered rows is the pattern III arrangement.
(c) The average diameter of the enamel prism is of the order of about 5μm.
(d) Prism boundaries are seen as the result of an optical effect caused by sudden changes in crystallite orientation at these regions.
(e) As the tails of prisms are directed cervically, the occlusal surface lies beyond the top of the micrograph.

72 (a) A = neonatal line.
(b) Zone C (below the neonatal line) represents the first-formed enamel and therefore the oldest.
(c) No. Apart from all the deciduous teeth, only the first permanent molars possess a neonatal line, indicating mineralisation commencing before birth.
(d) Yes, as deciduous enamel is softer than permanent enamel.

73 The zone labelled A, above the gingival sulcus, stains heavily because of the accumulation of dental plaque. Zone B adjacent to the gingival crevice is virtually plaque-free because of the firm apposition of the gingiva to the tooth, limiting plaque to the gingival margin. The paler staining zone labelled C, below the gingival crevice, is related to the presence of cells of the junctional epithelium.

74 A = enamel. B = primary enamel cuticle and pellicle. C = plaque with colonising bacteria.

75 The organic matrix in the centre of the field is fibrillar and banded and represents collagen. This would indicate that the tissue is developing enameloid, characteristically found in fish.

76 (a) A carious lesion is present in the enamel.
(b) Zone A is the main body of the lesion in which there is considerable loss of mineral.
(c) The enamel striae are particularly prominent and may represent a preferential pathway for acid attack.
(d) B is the surface zone of the carious lesion. Little apparent loss of mineral occurs in this surface zone owing to chemical interactions with mineral lost from the underlying body of the lesion and 'remineralisation' of the surface zone.

Dentine and Dental Pulp

77 (a) True. Thus, dentine has more inorganic material than bone or dental cementum but much less than dental enamel.
(b) False. The crystals of enamel are much larger in all dimensions.
(c) False. Primary curvatures are curvatures of the dentinal tubules produced by the odontoblasts as they migrate inwards and become crowded during dentinogenesis.
(d) False. There is considerable controversy regarding the extent of the odontoblast processes within the dentinal tubules. Ultrastructural evidence suggests cell processes gradually withdraw from the peripheral dentine (i.e. nearest the enamel-dentine junction).
(e) True. Predentine is the first-formed, unmineralised dentine (corresponding to osteoid).
(f) False. However, near the enamel–dentine junction, in the mantle dentine, the fibres run parallel to the tubules.
(g) False. Peritubular dentine is hypermineralised compared to intertubular dentine. It also differs from intertubular dentine in that it has little or no collagen and the inorganic material is not primarily hydroxyapatite.
(h) True, although there is much variation. A better direct relationship exists between the amount of peritubular dentine and the amount of attrition.
(i) True. Calcospherites are the 'circular' form of mineralisation within much of the dentine. Where adjacent calcospherites meet, but without fusion, hypomineralised interglobular dentine is seen.
(j) False. The presence of sensory intratubular axons has been confirmed by silver staining with light microscopy, electronmicroscopy and studies involving axonal transport of radioactive amino acids injected initially into the trigeminal ganglion.
(k) False. Dentine in human teeth is orthodentine (tubular dentine) and therefore normally without vascular inclusions. A form of dentine known as vasodentine showing numerous vascular channels is found in the teeth of some fish.
(l) True. The granular layer has also been related to the presence of minute interglobular areas produced as a result of incomplete mineralisation. It is not seen in demineralised sections.
(m) True. Structural lines in dentine include Schreger lines, contour lines of Owen, Von Ebner's lines, mineralising lines and neonatal lines (in some teeth). Only Von Ebner's lines and mineralising lines are truly incemental lines indicating the 'rhythmic' pattern of formation of dentine.
(n) False. Dead tracts occur because of the loss of the odontoblast processes within tubules and

thereby the 'emptying' of the tubules. Obliteration of the tubules with peritubular dentine results in translucent/sclerotic dentine.
(o) True. Extra-care must therefore be taken over cavity preparation within deciduous teeth to avoid exposure of their pulps.
(p) True. However, some physiological evidence is available suggesting that temperature changes may also be perceived by the dental pulp.
(q) True, because of crowding within the considerably reduced dimensions of the ageing pulp.
(r) False. Raschkow's plexus is located in the cell-free zone of the pulp, beneath the layer of odontoblasts.
(s) False. Most pulp stones lack tubular structures and are not surrounded by an odontoblast layer.
(t) True. Indeed, irregular secondary dentine is sometimes known as 'irritation' or 'response' dentine.

78 (a) A = dentinal tubule. B = intertubular dentine. C = peritubular dentine.
(b) This is a ground section because, in transverse section, the peritubular dentine (which is hypermineralised) is retained. The central dark 'spot' represents air and debris produced during tissue processing and is not the odontoblast process.
(c) Branching of the dentinal tubules is particularly marked near the enamel–dentine junction.
(d) The dentinal tubule may contain: an odontoblast process, peritubular dentine, organic sheaths (lamina limitans), terminal sensory axons, tissue fluid.
(e) Orthodentine and vasodentine are the two basic types of dentine found in the vertebrates. Plicidentine (folded dentine) and osteodentine (with dentinal 'trabeculae') are forms of orthodentine.

79 (a) A = granular layer (of Tomes). B = cementum. C = hyaline layer (of Hopewell-Smith). D = periodontal ligament.
(b) Label C, the hyaline layer,is approximately 15μm. In the crown, it is continuous with the mantle layer.

80 (a) This section is obtained from an old tooth as the apex of the root shows a conspicuous area of translucent dentine.
(b) Associated with physiological ageing the dentinal tubules, especially in the region of the root apex (zone A), become occluded by mineral in a process somewhat similar to that of peritubular dentine formation. The contents of the tubules in the apical region acquire the same refractive index as the intertubular dentine. When a ground section is placed in water (which has a different refractive index to dentine), areas of affected dentine at the root apex appear translucent (as there are no patent tubules for the water to fill) compared with the more opaque normal dentine (zone B) cervically (whose patent tubules become filled with the water).

81 (a) These areas (A) are known as interglobular dentine.
(b) A considerable proportion of the mineral in dentine is laid down in the form of globules, the calcospherites. Where the calcospherites do not completely fuse, hypocalcified areas persist between the globules (particularly in the coronal, circumpulpal dentine close to the enamel–dentine junction).
(c) Peritubular dentine does not form in regions of interglobular dentine.
(d) Conspicuous areas of interglobular dentine are seen in conditions in which the process of mineralisation or collagen formation is affected, such as hypophosphatasia, renal rickets, dentine dysplasias and Ehlers–Danlos syndrome.

82 (a) A = circumpulpal dentine. B = predentine. C = odontoblast layer. D = cell-free layer (of Weil) of the pulp. E = cell-rich layer of pulp.

(b) The difference in staining properties between dentine and predentine in decalcified sections occurs because, at the time of mineralisation, there is a modification of the composition of the organic matrix.
(c) The odontoblast cell body is characterised ultrastructurally by a basally located nucleus, by organelles associated with protein synthesis (ie Golgi apparatus, rough endoplasmic reticulum and mitochondria) in the supranuclear region, and by several small processes linked to adjacent odontoblasts or pulpal fibroblasts by gap junctions, tight junctions and desmosomes.
(d) In the dentine, dentine formation continues slowly throughout life to produce regular secondary dentine. Peritubular dentine also generally increases and may completely obliterate the tubule (to form sclerotic and translucent dentine). In the pulp, the formation of regular secondary dentine results in a decrease in the size of the pulp cavity with age. It is said, though awaits proper study, that there is declining cellularity and increased fibrosity. Older odontoblasts tend to be cuboidal rather than columnar and the odontoblast layer becomes narrower. The vasculature and nerve supply of the pulp are said to diminish. The most obvious feature of the ageing pulp is the presence of calcification. This calcification may be diffuse or may appear as discrete pulp stones (free or attached, tubular or non-tubular).

83 (a) Three main hypotheses have been put forward to explain dentine sensitivity implicating (i) nerves in dentine; (ii) the analogy of the odontoblast process to a nerve; and (iii) fluid movements in the dentinal tubules. Present experimental evidence favours the last hypothesis.
(b) Experiments could be (and have been) performed by applying stimuli such as heat and cold, osmotic pressure, and drying, all of which would be expected to produce fluid movements in the odontoblast tubules. This would eventually stimulate nerves in the pulp.

84 (a) Von Ebrer's lines which are of the order of 20μm apart.
(b) In the young tooth, the dentinal tubules are open and without much peritubular dentine. This, together with the large size of the pulp (and relative small size of the dentine), would enable a minimal, and early, carious lesion to be associated with the diffusion of noxious agents into the pulp. In the aged tooth, the thickness of the dentine and the obliteration of tubules by peritubular dentine would deny access to such noxious agents in the early lesion.

85 (a) Because of the general lack of staining, the presence of enamel (at the upper margins of the dentine), and the empty pulp chamber shown at the bottom of the picture, this is a ground section.
(b) A = dead tract. It is thought that in those regions where the odontoblasts die (usually because of noxious stimuli), the ends of the associated dentinal tubules become sealed by calcific material. The blackened appearance seen in routine ground sections may be related to the retention of air in the 'emptied' tubules which have not been penetrated by the viscous mounting medium.
(c) B = secondary dentine. This can be considered as a protective response of a vital pulp to seal off the dead tract. In this site, the newly-formed dentine has fewer tubules than primary dentine and only a small proportion of the tubules are continuous across the two tissues: it is then referred to as irregular secondary dentine (or tertiary dentine).
(d) Dead tracts are often found beneath areas of attrition. Indeed, exposed dentine may be present on the crown.

86 The dentinal tubules have become completely occluded by mineral deposition (arrows). In such regions, tubules are not evident in routine ground sections, producing a tissue known as sclerotic dentine.

87 The specimen shown is of the pulp chamber of a tooth with the surrounding dentine undergoing a process of internal resorption. Note the large, osteoclast-like cells (odontoclasts, dentinoclasts) within resorption lacunae. Internal resorption is usually associated with the presence of a dense, vascular connective tissue within the pulp and the loss of the odontoblast layer. Internal resorption may be phasic, such that resorption ceases and the pulp attempts a process of healing by the deposition of bone-like tissues. There is some debate as to whether internal resorption is initiated within the pulp; in many situations the pathology starts within the periodontal ligament and spreads internally via a small lateral root canal.

88 (a) Because of the staining and because of the presence of cells, this is a demineralised section.
(b) Pulp stones (denticles).
(c) Pulp stones may be classified as true (if consisting of tubular dentine surrounded by an odontoblast layer) or false (when generally consisting of concentric layers of calcified material with no odontoblast layer). Free pulp stones lie within the pulp, while attached pulp stones become incorporated into the dentine wall.
(d) Large pulp stones are evident on radiographs. Pulp stones are nearly always symptomless.

89 This is a cross-section of osteodentine from a fish (an eagle ray). It is traversed by vascular pulp canals (A) which are themselves surrounded by concentric laminae of dentine termed denteons (B). Unlike bone, however, these laminae do not contain cells but house the processes of odontoblasts whose cell bodies line the vascular spaces. Between the denteons lie calcified interstitial tissue (C) which is generally cell-free.

Cementum and Alveolar Bone

90 (a) False. These values are composition by weight.
(b) False. Most cementoblasts are derived from ectomesenchmal cells of the investing layer of the dental follicle.
(c) True, as cellular cementum is formed at a faster rate.
(d) True. Afibrillar cementum consists of well-mineralised ground substance which may be of epithelial origin.
(e) False. The periodontal ligament which supplies nutrition to the cementum has alternative sources for its blood supply.
(f) False. Uncalcified cementum matrix is termed precementum. Intermediate cementum is a calcified layer adjacent to the dentine surface which is characterised by possessing wide, irregular branching spaces.
(g) False. Sharpey fibres in alveolar bone are larger.
(h) False. Collagen in cementum is virtually all type I collagen.
(i) True. This is because the collagen fibres in the matrix show different orientations in the two tissues.
(j) False. Canaliculi in cementum are preferentially oriented towards the periodontal ligament.
(k) True. Bundle bone may exhibit resting lines related to physiological drift.
(l) True. The thinness of the bone allows for simple infiltration anaesthetic techniques for tooth extraction in this region.
(m) True. This is because the bone here is compact. Transalveolar fibres would not cross areas of cancellous bone.
(n) True. A marker for osteoclasts is acid phosphatase.
(o) True. Many of the factors eventually leading to bone resorption affect receptors on the osteoblast rather than the osteoclast.
(p) True. In the adult this feature is lost.
(q) False. Intracellular collagen profiles have not been found in osteoclasts.
(r) True. It is likely that the bone activity is an effect of the drift rather than the direct cause.

(s) True. The orientation of the collagen will change from lamella to lamella.
(t) False. Individual trabeculae in cancellous bone are about 50 µm thick.

91 (a) A = acellular cementum. B = cellular cementum. C = granular layer (of Tomes).
(b) No. Typically, cellular cementum overlies acellular cementum.
(c)

Acellular Cementum	Cellular Cementum
No cells	Cells
Slow rate of formation	Rapid rate of formation
Incremental lines closer together	Incremental lines further apart
Precementum layer narrower	Precementum layer wider

(d) Acellular cementum is mainly extrinsic fibre cementum while cellular cementum is primarily mixed fibre cementum.
(e) The nature of the reparative tissue depends on the speed of formation. When this is slow, the repair tissue resembles primary cementum. When the repair tissue is formed rapidly, it closely resembles woven bone.

92 (a) A = acellular cementum. B = cellular cementum. C = granular layer (of Tomes) in root dentine.
(b) The colour differences reflect the differences in orientation of collagen fibres in acellular and cellular cementum. In acellular cementum, the fibres are mainly extrinsic and are oriented perpendicular to the root surface. In cellular cementum, there are additional intrinsic collagen fibres that are oriented more parallel to the root surface.
(c) As the first-formed cementum is acellular and later becomes overlaid more apically with cellular cementum, the root apex must be located beyond the bottom of the micrograph.

93 (a) A = cementum layer. B = dentine. C = periodontal ligament. D = reversal line. E = reparative cementoblast layer.
(b) Most roots of permanent teeth show small localised areas of root resorption. This tends to increase with age. Root resorption may also accompany orthodontic tooth movement if the loading is not very carefully controlled.

94 (a) As the section is stained and contains cellular material, it is a demineralised section.
(b) A = osteoclasts. B = osteoblasts. C = osteocytes embedded in the bone matrix.
(c) No. Osteoblasts are cells of the connective tissue series (which may originally be of ectomesenchymal origin), while osteoclasts are derived from blood cell precursors.
(d) Osteocytes contact each other via gap junctions.
(e) The darker staining of the matrix associated with the mineralised bone (D) compared with that of unmineralised osteoid (adjacent to layer B) is due to biochemical changes at the mineralising front.

95 (a) A = Haversian canal. B = Haversian system (osteon). C = Interstitial lamella.
(b) In ground sections, cellular material (ie osteocytes) is lost and the black spaces represent lacunae filled with air or cell debris.
(c) The organic matrix, consisting primarily of type I collagen, comprises about 36% of the tissue by volume.

96 (a) Microradiography.
(b) The varying shades of white and grey reflect the density (and therefore the degree of mineralisation) of the bone. The darker the region of bone (ie the more radiolucent), the less the degree of mineralisation. This illustrates the bone is continually turning over, cancellous bone more rapidly than compact bone.

97 (a) The smooth, scooped-out appearance in the upper part of the micrograph represents an

area of bone resorption. The granular appearance in the lower part of the micrograph represents an area of bone formation.
(b) The structures arrowed represent Sharpey fibres.

98 (a) Hypercementosis.
(b) The increased thickness of cementum at the root apex may be a response to attrition of the crown of the tooth with resulting compensatory eruption.
(c) Localised hypercementosis at the root apex may be a response to chronic pulp inflammation.
(d) Generalised hypercementosis is associated with Paget's disease.
(e) Hypercementosis may cause difficulty during tooth extraction, necessitating surgical removal of the overlying bone. Two adjacent teeth may even become fused by union of their cement, a condition referred to as concrescence.

99 (a) A = Lamina dura.
(b) The radiopacity of the lamina dura is not due to hypermineralisation but is a consequence of superimposition.
(c) No. Between the molar teeth, the alveolar crests are flat and horizontal. Between the incisors, the alveolar crests rise only as points or spines.
(d) Discontinuity of the lamina dura is indicative of a pathology.
(e) Chronic inflammatory periodontal disease begins in the gingiva, above the alveolar crest and the periodontal ligament. Radiologically, once the bone at the alveolar crest becomes involved in the disease process, and the condition moves from being gingivitis to periodontitis, the crests resorb either with an even disposition in all areas such that the pattern of bone loss is horizontal or, with advanced tissue destruction, with uneven, irregular vertical bone resorption.
(f) Yes. A thin crack-like radiolucent line would initially indicate the fracture site along the root. However, this could gradually disappear for repair with a cementum-like tissue-occurred.
(g) About three weeks after extraction.

100 (a) The diseased state as there is loss of alveolar bone which lies well below the cervical margin.
(b) Not necessarily, as experimental removal of portions of alveolar bone in animals has been undertaken without resulting in any significant increase in tooth morbidity.

Periodontal Ligament

101 (a) False. Its normal width is 0.2mm, although there is much variation between teeth and within individual teeth with age.
(b) True. Other 'principal' fibres are the dento-alveolar crest fibres, horizontal fibres, apical fibres and the inter-radicular fibres.
(c) False. Collagen fibrils with small diameters are associated with connective tissues under compression. Tissues under tension have two groups of fibrils with small and large diameters.
(d) False. It is mainly near the alveolar crest that the fibres are attached into the alveolar bone as Sharpey fibres. Elsewhere, many of the fibres terminate at the bone surface or around adjacent blood vessels.
(e) True. Furthermore, the occurrence of mineralisation at approximately right angles to the long axes of the fibres is indicative of tensional forces.
(f) False. There is no histological evidence for an intermediate fibre plexus in the periodontal ligament.
(g) False. To visualise oxytalan it is necessary to oxidise the tissue and then stain with elastin.
(h) True. However, decreased loading is not associated with a decrease in the number of oxytalan fibres.

(i) True. Even the collagen fibres are composed of 60% ground substance by volume.
(j) False. Myofibroblast-like cells are produced when periodontal cells are cultured on collagen gels but are not usually seen *in vivo*.
(k) True. The process of intracellular degradation of collagen resembles that of phagocytosis. Thus, periodontal fibroblasts are both -blastic and -clastic in terms of collagen metabolism.
(l) False. The periodontal fibroblasts do show numerous intercellular junctional organelles but this is unusual for fibrous connective tissues in adult animals but not uncommon in fetal mesenchyme.
(m) False. The cementoblasts are derived directly from the periodontal connective tissues, cementoclasts (odontoclasts), which are osteoclast-like, are derived from circulating monocytes.
(n) True. They may appear either as isolated islands of cells or as interconnecting strands or cords of cells. The rests show little metabolic activity but may be involved in the development of periodontal cysts if stimulated pathologically.
(o) False. Much of the blood supply is also derived from the vessels in the alveolar bone and from the gingiva. If this were not so, apicectomies (endodontic treatment) would not be possible.
(p) True. Most fibrous connective tissues have a vascular bed with continuous capillaries.
(q) True. These are involved in mechanoreceptor and nocireceptor activity as well as vasomotor control.
(r) False. Specialised, encapsulated mechanoreceptors are rarely found in the periodontal ligament and the periodontal mechanoreceptors have recently been characterised as being unencapsulated Ruffini-like terminals.
(s) False. Most features are suggestive of a connective tissue placed in compression during loading.
(t) True. Indeed, many of the features of the extracellular matrix and fibroblast morphology indicate that the periodontal ligament is mesenchymal-like. This may have clinical relevance in terms of understanding the reactions to pathological stimuli and to healing following tissue insult as well as to the nature of the tissue to be grafted into periodontal defects following inflammatory periodontal disease.

102 (a) A = alveolar bone. B = osteoblast layer. C = fibroblasts and collagen fibres within the body of the periodontal ligament. D = cementoblast layer. E = cementum.
(b) The width of the periodontal space in the healthy state is said to be 0.2mm. The width is thought to be narrowest in the mid-root region, near the fulcrum about which the tooth moves when an orthodontic load (tipping load) is applied to the crown. The space is reduced in non-functioning and unerupted teeth and is increased in teeth subjected to heavy occlusal stress. With age, the periodontal space narrows. The periodontal spaces of the permanent teeth are said to be narrower than those of the deciduous teeth.
(c) The collagen fibres are arranged in fibre bundles with specific orientations and names, ie dento-alveolar crest fibres, horizontal fibres, oblique fibres, apical fibres and inter-radicular fibres. The oxytalan fibres are analogous to pre-elastin and, in some species, may be replaced by elastin. Reticulin fibres are related to basement membranes within the periodontal ligament.
(d) The epithelial rests (of Malassez) are non-connective tissue cells which are a normal feature of the periodontal ligament. Defence cells in the ligament may include macrophages, mast cells, and eosinophils.
(e) The tooth is undergoing physiological drift and, as bone is being deposited on this wall of the socket, the tooth must be moving to the left of the micrograph (the alveolar wall on that surface would exhibit resorption).

103 (a) Epithelial cell rests (of Malassez).
(b) Uniquely as epithelial cells, they are completely surrounded by a basement membrane and

by connective tissue cells.
(c) The main clinical significance of epithelial cell rests relates to their propensity to form cysts, or even tumours. It has been suggested that their presence may help inhibit root resorption and ankylosis.

104 The presence within the cell of intracellular organelles such as rough endoplasmic reticulum, mitochondria, various vesicles and microtubules, indicates this cell is actively synthesising and secreting proteins. The presence of what appears to be collagen fibrils sectioned transversely in the extracellular space close to the cell membrane points to the cell being a fibroblast. Furthermore, the presence in the central part of the cell of intracellular collagen profiles may indicate that the cell is responsible for degradation of this protein.

105 (a) A = alveolar crest fibres of periodontal ligament. B = horizontal fibres of periodontal ligament. The fibres are composed of collagen (~80% type I and ~20% type III).
(b) Collagen in the periodontal ligament has a very rapid turnover, probably in the order of days.
(c) The reason that cells are not evident in the periodontal ligament is that a special stain has been used (van Gieson) to stain only the collagen fibres, and there is no counterstain for the cells.
(d) C = alveolar bone. D = junctional epithelium.

106 (a) Oxytalan fibres.
(b) The oxytalan fibre comprises a collection of unbanded fibrils arranged parallel to the long axis of the fibre. Each fibril is about 15nm in diameter and an interfibrillar amorphous material is present in variable amounts. In cross-section, the fibre is oval and may be up to 1μm in diameter. It can therefore be readily distinguished from collagen.
(c) The oxytalan fibres constitute about 3% by volume of the extracellular fibres of the periodontal ligament.
(d) A = Sharpey's fibres. In the region of the alveolar crest, where the bone type is mainly compact, Sharpey's fibres may pass straight through to become continuous with similar fibres in the root of the adjacent tooth. These fibres may then be called transalveolar fibres.

107 (a) The cell is an osteoclast.
(b) A = multinucleated cell. B = brush border with microvilli where resorption is taking place. C = annular zone (which forms a seal).
(c) The osteoclast resorbs both the inorganic and organic components of bone.

108 (a) A = alveolar bone. B = root dentine. C = periodontal connective tissue. D = thin walled blood vessels of the periodontal ligament. E = nerve bundles within periodontal ligament.
(b) The periodontal ligament has a richer vasculature than most other fibrous connective tissues. There is a prominent cervical plexus of capillary loops around the gingival crevice. The capillaries are fenestrated.
(c) An intermediate plexus implies that there are separate alveolar-related and tooth-related fibres which 'mesh' together towards the middle of the periodontal ligament. This plexus is thought to be the major site of remodelling of the ligament during tooth movement. Histologically, however, the plexus is an artefact produced by cutting across wavy periodontal collagen arranged as sheets, which ultrastructurally are seen to pass uninterruptedly across the periodontal space. Some studies using radio-active proline suggest that there is more labelling towards the centre of the ligament and this might be confirmed by an increase in intracellular collagen profiles in the fibroblasts centrally. However, there is some evidence that remodelling during tooth movements occurs close to the tooth surface.

109 Although the periodontal ligament is often regarded as highly specialised, this can only be confirmed by attempts to find an analogue elsewhere in the body. This may also be important to aid our understanding of disease processes in the tissue and also to find a suitable grafting tissue to replace periodontal connective tissue lost because of disease.
Initially, the periodontal ligament was compared with connective tissues in adult animals which are known to resist either compressive or tensional loading. Although most of the structural and biochemical features suggested a tissue under compression, the results were inconclusive. However, comparing the periodontal ligament with connective tissues in the foetus shows that the ligament is analogous to mesenchyme.

110 The mandibular second deciduous molar lies below the level of the occlusal plane (ie infra-occluded). This is probably due to ankylosis of the tooth to the jaw, which renders the tooth immobile. It may be necessary to extract the tooth otherwise, with subsequent alveolar bone growth, the deciduous molar may become completely embedded within the jaw (submerged tooth).

Oral Mucosa

111 (a) True. The involucrin becomes crossliked by the enzyme transglutaminase.
(b) True. Parakeratosis is normally present in the masticatory mucosa of the gingiva and palate.
(c) True. These cells include melanocytes, Langerhans cells and Merkel cells.
(d) False. Langerhans cells are derived from blood cells.
(e) False. An interdental col only occurs below contact points between the cheek teeth.
(f) False. The sulcular epithelium is non-keratinised.
(g) True. The internal basal lamina is found at the interface with the tooth surface, the external basal lamina at the interface with the underlying connective tissue.
(h) True. Regeneration occurs from the adjacent oral epithelium. If this were not true, much periodontal surgery would be unsuccessful.
(i) False. No submucosa exists beneath the attached gingiva.
(j) False. The alveolar mucosa is a lining mucosa.
(k) False. A stratum lucidum is absent from the oral epithelium.
(l) False. Fungiform papillae are covered with a non-keratinised epithelium.
(m) True. The vermilion zone lacks mucous glands.
(n) True. The tongue develops from the floor of the pharyngeal (branchial) arch system.
(o) True. These fibres provide an anatomical basis whereby all the teeth in the arch are linked together.
(p) True. The reason for so many is not known. Keratin 14 is present throughout the oral epithelium, while keratin 19 is only found in the stratum germinativum.
(q) False. The free gingiva is smooth.
(r) False. Turnover time for the hard palate is of the order of about three to four weeks, whereas that for buccal mucosa is nearer two weeks.
(s) True. The non-dendritic Merkel cell also contains some tonofibrils.
(t) False. The turnover time of gingival collagen is about three times slower.

112 (a) Dento-gingival junction.
(b) A = attached gingival epithelium. B = free gingival epithelium. C = sulcular (crevicular) epithelium. D = junctional epithelium. E = enamel space. F = dentine. G = cementum.
(c) A and B = masticatory (keratinised) epithelium.
C and D = lining (non-keratinised) epithelium.

(d) The junctional epithelium (D) has the highest turnover rate.
(e) The junctional epithelium has fewer desmosomes, larger intercellular spaces, two basal lamina, a higher turnover rate, is more permeable, and contains more organelles associated with the transport and extracellular secretion of protein.

113 (a) Lip.
(b) A = skin of lip. B = vermilion zone. C = labial mucosa of lip. D = orbicularis oris muscle.
(c) E = mucous glands of lip.

114 (a) The thin keratinised layer, the absence of skin appendages, and the pronounced dermal papillae indicate this is the vermilion zone of the lip.
(b) These are clear cells and represent non-keratinocytes (eg melanocytes) as visualised in routine haematoxylin and eosin preparations.

115 (a) A = tonofibril. B = keratohyalin granule. C = nucleus.
(b) Stratum granulosum.
(c) Keratohyalin granules contain profillagrin, the precursor to fillagrin.
(d) Yes.

116 (a) A = stratum germinativum. B = stratum spinosum. C = stratum corneum.
(b) Because of the keratinised layer and the prominent epithelial rete, it is likely to come from a masticatory mucosa such as the hard palate or gingiva.
(c) The island of lamina propria apparently surrounded by epithelium is merely the result of an oblique section across the epithelium.
(d) Skin would show sweat glands and hair follicles, and may contain an extra layer near the surface, the stratum lucidum.

117 (a) Because of the presence of muscle and glandular tissue, and because of the absence of skin and masticatory mucosa, this section is from the soft palate.
(b) A = stratified squamous (lining) epithelium. B = respiratory (ciliated) epithelium.
(c) These (C) are mucous glands and they probably derive their parasympathetic nerve supply from the facial nerve (via the pterygopalatine ganglion), which is distributed in branches emanating from this ganglion (eg lesser palatine nerve).
(d) The muscles of the palate (D) are innervated by the cranial accessory nerve (via the pharyngeal plexus), except for the tensor veli palatini muscle which is supplied by the mandibular branch of the trigeminal nerve.

118 (a) Circumvallate papilla of tongue.
(b) Lining (non-keratinised) epithelium.
(c) B = taste bud, innervated by the glossopharyngeal nerve.
(d) C = Serous glands (of Von Ebner).

119 (a) A = hemidesmosome. B = lamina lucida. C = lamina densa.
(b) The lamina lucida contains laminin.
(c) The lamina densa contains type IV collagen.
(d) The lamina lucida and lamina densa are products of the stratum germinativum cells of the epithelium.

120 (a) Hard palate.
(b) Masticatory (keratinised /parakeratinised) epithelium.
(c) B = mucous glands in submucosa. C = greater palatine artery. D = duct of mucous gland. E = bone of hard palate.
(d) The parasympathetic innervation of minor mucous glands is the greater petrosal branch of the facial nerve via the pterygopalatine ganglion and greater palatine nerve.

121 (a) A = junctional epithelium. B = cementum. C = enamel space.
(b) A basal lamina-like structure.
(c) As the attachment has migrated onto the cementum, this must represent an older patient.
(d) The apical migration of the junctional epithelium on to cementum, together with an obvious infiltration of inflammatory cells, indicates this to be diseased tissue.

122 The gingivae have become grossly hyperplastic and there has been a proliferation of the underlying connective tissue elements (possibly as an exaggerated reaction to only mild local irritation from plaque, calculus etc, although this is in dispute). The hyperplasia may be sufficiently marked to completely cover the teeth. Note that the gingival hyperplasia is not seen in edentulous regions. The signs are very similar to those seen in hereditary gingival fibromatosis.

123 (a) A nasopalatine cyst arising from the remnants of the nasopalatine duct.
(b) The incisive papilla
(c) The incisive fossa (foramen) and the nasopalatine nerves.

124 (a) The structure represents a gingival abscess originating from the heavily filled mandibular permanent first molar and which would discharge into the vestibular sulcus.
(b) An abscess 'pointing' in the vestibular sulcus may pass there from the tooth 'along the lines of least resistance'. Should the spread of the infection be restricted by the buccinator muscle, the abscess will appear in the vestibular sulcus intra-orally. If the infection passes through the muscle, or more likely below the attachment of buccinator on the buccal alveolar plate of the mandible, the infection will spread into the face.

Salivary Glands

125 (a) False. Salivary glands are merocrine glands (ie only the secretion of the cell is released).
(b) False. The facial nerve is superficial to the external carotid artery.
(c) False. The two parts of the gland are continuous around the posterior border of the mylohyoid muscle.
(d) True. The ducts from the anterior part of the gland may unite to form a larger duct (Bartholin's duct) which either joins the submandibular duct or drains directly into the floor of the mouth at the sublingual papilla.
(e) False. It is derived from the lesser petrosal nerve and therefore is associated with the glossopharyngeal nerve and not the facial nerve.
(f) False. The glands are mucous.
(g) True. The zymogen granules are concentrated at the distal end of the cell.
(h) True. Active transport occurs at this surface, and the fluid in the duct is transformed into a hypotonic one.
(i) True. These cells are contractile.
(j) True. The mucous acini take up a purplish colour.

126 A = serous acinus (due to its granular appearance). B = intercalated duct. C = striated duct.

127 This electronmicrograph is of an intercalated duct. The single layer of cuboidal lining cells lacks the intracellular organelles of secretory acini, while the nuclei appear prominent and centrally positioned in the relatively scanty cytoplasm.

128 Because of the position of the nuclei and the nature of the secretory granules, A represents a serous cell and B a mucous cell. The structure is therefore part of a serous demilune (found in the submandibular or sublingual glands).

129 Lying at the periphery of the acinus, the cell A has a tapering process apparently filled with microfilaments. It therefore represents a contractile myoepithelial cell. Myoepithelial cells are derived embryologically from neural crest tissue.

130 (a) A = serous demilune. B = lumen of collecting duct. C = mucous acinus.
(b) The collecting duct within the sublingual gland is homologous with the striated duct of the submandibular gland, but lacks the striations. This may be associated with the formation of a sodium-rich saliva.

131 The patient has a stone (sialolith) within the right submandibular duct, which is radio-opaque and is visible on the radiograph within the outline of the mandible. This is partially obstructing the flow of saliva and causes the gland to swell at mealtimes, giving discomfort. The presence of a stone predisposes to infection and this is responsible for the bad taste.

132 (a) The tumour lies in the parotid region.
(b) The tumour is likely to be benign because it is well-defined, with a capsule, and is slow growing.
(c) The parotid gland is itself innervated (secretomotor) by postganglionic parasympathetic fibres from the otic ganglion which travel to the gland via the auriculotemporal branch of the mandibular nerve. The preganglionic fibres pass with the lesser petrosal branch of the glossopharyngeal nerve. There is some evidence that the secretomotor supply may also be derived from the chorda tympani branch of the facial nerve. The sympathetic supply to the gland initially comes from the superior cervical sympathetic ganglion. From here, the innervation reaches the gland via the plexus around the middle meningeal artery, the otic ganglion and eventually the auriculotemporal nerve. Sensory fibres to the connective tissue within the parotid gland are derived directly from the auriculotemporal nerve. The parotid fascia covering the gland receives a sensory innervation from the great auricular nerve of the cervical plexus and the skin overlying the gland receives its nerve supply from the great auricular nerve and the auriculotemporal and buccal branches of the mandibular nerve. If the facial nerve is involved, a paralysis may follow.
(d) A parotid tumour may spread inwards from the deep portion of the gland which is situated at the posterior boundary of the infratemporal fossa. From this site, the tumour can spread to extend into the palate and into the pharynx and thus be associated with dysphagia.

133 In this particular region of the mandible, a portion of the submandibular gland may invaginate into the bone, producing a Stafne cavity. This can take on the appearance of a cyst, although attempts to enucleate such a 'cyst' would have dire consequences. Should radio-opaque dye be injected into the submandibular duct (to produce a sialogram), it would be possible to confirm that the tissue within the cavity is glandular tissue.

Development of Face, Palate and Tongue

134 (a) True. The facial processes are also demarcated by grooves which become flattened out by the proliferative and migratory activities of the mesenchymal cells.
(b) True. The connective tissue cells migrate from the neural crest and muscle cells from the paraxial mesenchyme.
(c) False. Such sheets were once thought to have a role in the development of facial clefts.
(d) True. The nasal placodes also 'sink' into the underlying mesenchyme to form the nasal pits (the primitive nasal cavities).
(e) False. The otic placode contributes to the development of the membranous labyrinth of the

inner ear.
(f) False. The medial and lateral nasal processes appear around the nasal placodes and pits.
(g) True. With further development, however, the maxillary processes continue to migrate to the midline to meet each other.
(h) True. The naso-optic furrow normally would invaginate into the mesenchyme, becoming a canal and forming the naso-lacrimal duct.
(i) False. Although the philtrum of the upper lip is innervated by the maxillary nerve (the nerve of the maxillary process), with a bilateral cleft it is innervated by the ophthalmic nerve (the nerve of the frontonasal process).
(j) True. Note that it is the primary palate in which lie the nasal pits and that behind the primary palate is a common oro-nasal chamber which becomes separate oral and nasal cavities with the development of the secondary palate.
(k) False. The palatal shelves are outgrowths of the maxillary processes.
(l) False. For some mammals, however, formation of the soft palate does not involve palatal shelf elevation.
(m) False. Present evidence suggests that the force for palatal shelf elevation is produced within the shelves.
(n) True. Indeed, it has been proposed that it is the hydration of this ground substance component which produces the intrinsic shelf elevation force.
(o) False. Shelf elevation takes place during the 8th week of intra-uterine life.
(p) True. The epithelial cells may also differentiate into mesenchymal cells.
(q) False. The major controlling influence resides with the mesenchymal component.
(r) True. Immunohistochemical studies indicate the presence of type IX collagen and receptors for epidermal growth factors prior to breakdown of the midline epithelial seam.
(s) True. Submucous clefts are therefore likely to arise because of failure of the process of fusion of the palatal shelves rather than failure of the process of shelf elevation.
(t) False. There is no premaxilla in man. All components/processes of the maxillary bone ossify from a single centre that is initially located close to the developing deciduous canine tooth.
(u) False. It is derived from the first branchial arch.
(v) False. The embryological division probably corresponds with the division of the tongue into different areas of innervation. Consequently, the embryological division would lie just in front of the circumvallate papillae.
(w) False. The area around the vallecula is innervated by the internal laryngeal nerve.
(x) False. The musculature of the tongue arises from occipital myotomes (hence the innervation by the hypoglossal nerve).
(y) False. The epithelial lining is endodermal in origin, the tongue developing from the floor of the branchial (pharyngeal) arch system.

135 (a) A = mandibular process. B = maxillary process. C = lateral nasal process. D = medial nasal process. E = naso-optic furrow. F = nasal pit.
(b) The nasal fin is a sheet of epithelium located in front of the nasal pit. It was once believed that the nasal fin formed an epithelial partition between the maxillary and medial nasal processes. However, a bridge of mesenchyme known as the maxillary isthmus joins the two processes in front of the nasal fin. The nasal fin is eventually incorporated either into the walls of the nasal pit or into the oronasal membrane. Should the fin become enlarged, it may contribute a line of weakness between the mesenchyme of the maxillary and medial nasal processes and eventually lead to the formation of a cleft in this region.
(c) Pattern formation in some developing organs is controlled by retinoids (vitamin A derivatives), which form morphogenetic gradients within the tissues. Although such gradients

have not yet been demonstrated in the face, a similar mechanism seems likely to be present as the facial primordia are sensitive to exogenous retinoic acid and the mesenchymal cells contain specific retinoic acid receptors.

(d) Unilateral cleft lip, bilateral cleft lip, median cleft lip (with nasal defect), oblique facial cleft (with cleft lip), median mandibular cleft, macrostomia. There are also clefts related to the orbit.

(e) Entrance to stomodeum (mouth).

136 (a) A = palatal shelves. B = developing tongue. C = Meckel's cartilage (cartilage of the first branchial arch). D = developing bone of mandible. E = tooth germ.

(b) The secondary palate is completed during the twelfth week of development.

(c) It now appears that there is a force of elevation intrinsic to the palatal shelves. However, the mechanism responsible is controversial. It has been proposed that the force results from hydration of ground substance components in the shelf mesenchyme and/or from proliferation, migration or contraction of mesenchymal cells.

(d) Once elevated, the palatal shelves fuse by firstly adhering together by means of a 'sticky' glycoprotein, then by the epithelial cells developing desmosomes and forming a midline epithelial seam. This seam subsequently thins and breaks down so that there is a merging of the mesenchyme within the palatal shelves. The midline epithelial seam breaks down as a result of programmed cell death and by the migration of the epithelial cells and eventual differentiation into mesenchymal cells.

(e) The mildest form of cleft affects the uvula (bifid uvula). Early disturbance of palatal elevation or fusion can result in an extensive cleft of the secondary palate. Should the cleft involve the primary palate, it may extend to one or both sides of the incisive foramen to include the alveolus. A submucous cleft describes a condition where, despite the fact that the palatal mucosa is intact, the bone/musculature of the palate is deficient beneath the mucosa.

137 A = lateral lingual swellings (first branchial arch).
B = tuberculum impar (first branchial arch)
C = copula (mainly from third branchial arch). Note the thyroid gland develops between B and C.

138 A median palatine cyst is derived from the epithelium which persists in the fusion line of the two palatal shelves once they have elevated. Normally, the epithelium (the midline epithelial seam) breaks down by a combination of programmed cell death and redifferentiation into mesenchyme. However, remnants may become cystic. Because the embryonic epithelium lining the palatal shelves has the potential to differentiate into either respiratory epithelium (pseudostratified, ciliated, columnar epithelium) on the nasal surface or stratified squamous epithelium on the oral surface, the cyst may have an epithelial lining of either type.

139 (a) Palatal clefts occur approximately once in every 1000 births.

(b) Polygenic discontinuous multifactorial mode of inheritance.

(c) Yes.

(d) Clefts of the palate may arise because of failure of elevation of the palatal shelves; because of asymmetrical development of the shelves on either side; as a result of deficiency in size of the palatal shelves; or because the shelves, although elevated, fail to fuse properly as a result of defective initial contact, failure of the midline epithelial seam to form or subsequently break down, or deficient migration/proliferation of the mesenchyme across the fused shelves.

140 The swelling in the midline of the tongue might appear smooth and could be related to an area related to the embryonic tuberculum impar. However, that iodine was taken up by the swelling suggests that it is a 'lingual thyroid', the thyroid gland originating embryologically from the region around the foramen caecum. In this case, the gland did not migrate but remained on the tongue as a fully functioning thyroid gland, and should therefore not be removed.

Development of the Jaws

141 (a) True. Most of the facial skeleton develops intramembranously.
(b) False. The centre of ossification is located close to the developing deciduous canine tooth (there is no premaxilla in Man).
(c) True. Secondary cartilages have been described in the regions of the zygomatic and alveolar processes, but these rapidly ossify.
(d) True. There is also considerable surface remodelling.
(e) True. This accounts for some of the changing occlusal relationships between the teeth during childhood.
(f) False. The maxillary, sphenoidal and ethmoidal sinuses are rudimentary at birth. It is the frontal air sinus which appears much later.
(g) True. Thereafter, ossification continues within the condensation of mesenchyme around Meckel's cartilage (the cartilage of the first branchial arch).
(h) False. Although important, the role of the secondary cartilage in the mandibular condyle for growth of the ramus is questioned by experiments involving surgical removal of the cartilage.
(i) True. The ramus of the mandible also assumes a more vertical relationship to the body of the mandible.
(j) True. In common with other symphyses, the joint is a secondary cartilaginous joint consisting of a 'sandwich' of: bone, cartilage, fibrous tissue, cartilage, bone.

142 (a) A = Meckel's cartilage. B = dental lamina. C = developing tongue. D = neurovascular bundle surrounded by developing bone of the mandible.
(b) Meckel's cartilage is the cartilage of the first branchial (pharyngeal) arch. In the mesenchyme around this cartilage, the body of the mandible is formed (ie intramembranously). The cartilage also gives rise to the lingula on the ramus of the mandible, the sphenomandibular ligament, the spine of the sphenoid bone and the malleus and incus ear ossicles.
(c) The temporomandibular joint develops from mesenchyme lying between the developing mandibular condyle below and the temporal bone above, which themselves develop intramembranously. During the 12th week of intra-uterine life, two clefts appear in the mesenchyme, producing the upper and lower joint cavities, the remaining intervening mesenchyme becoming the intra-articular disc. The joint capsule develops from a condensation of mesenchyme surrounding the developing joint. At birth, the mandibular fossa is flat and there is no articular eminence, the latter only becoming prominent following the eruption of the deciduous dentition.

143 (a) A = Basion. B = Sella point. C = Nasion. D = Gnathion. E = Plane describing cranial base. F = Y-axis.
(b) Growth of the mandible occurs by the remodelling of bone. In general terms, increase in the height of the body occurs primarily by formation of alveolar bone, though some bone is also deposited along the lower border of the mandible. Increase in the length of the mandible is accomplished by bone deposition on the posterior surface of the ramus with compensatory resorption on its anterior surface, accompanied by deposition of bone on the posterior surface of the coronoid process and resorption on the anterior surface of the condyle. Increase in width of the mandible is produced by deposition of bone on the outer surface of the mandible and resorption on the inner surface.
There is some controversy concerning the role of the condylar cartilages in mandibular growth. One view states that continued proliferation of this cartilage is primarily responsible for the increase in both the mandibular length and the height of the ramus. Alternatively, it has been suggested that proliferation of the condylar cartilage is a response to growth and not its cause. The latter view has been supported by experiments showing that mandibular growth is relatively

unaffected following condylectomy, providing normal mandibular function is maintained.
(c) Although the mandible is a single bone, it may be thought of as a number of 'skeletal units' each associated with one or more soft tissue 'functional matrices'. The behaviour of these matrices primarily determines the growth of each skeletal unit. For example, the coronoid process forms a skeletal unit acted upon by the temporalis muscle. Sectioning of the temporalis muscle during early mandibular development may result in atrophy or complete absence of a coronoid process in the adult mandible. Similarly, the alveolar process is influenced by the teeth, the condyle by the lateral pterygoid muscle, the ramus by the medial pterygoid and masseter muscles, and the body of the mandible by the neurovascular bundle.
(d) Growth of the maxilla occurs by bone remodelling (ie surface deposition of bone with associated resorption) and by sutural growth. Among the agents which provide the forces separating the maxilla from the adjacent bones—thus permitting growth at the sutures—are the growing eyeballs, cartilaginous nasal septum and orbital pad of fat. Thus, growth of the maxilla is not an isolated phenomenon but occurs in association with the development of the orbital, nasal and oral cavities. It has been suggested that the growing nasal septum pulls the maxilla forward by means of a septo-premaxillary ligament which runs from the anterior border of the nasal septum postero-inferiorly towards the anterior nasal spine and the intermaxillary suture. As in the lower jaw, growth in height of the maxilla is related to the development of the alveolar process. It is difficult to determine how much of the adult alveolus is the result of bone deposition and how much is due to bodily displacement of the maxilla. Studies using metal implants suggest that each method of growth contributes equal amounts. Increase in height of the nasal cavity is associated with resorption of bone on the upper surface of the palatine process of the maxilla and deposition of bone on the lower surface.

144 (a) Cartilage.
(b) As hypertrophic chondrocytes are aligned in columns on either side of the cartilage, the structure is a synchondrosis. In the skull of a 10-year-old child, this would represent the spheno-occipital synchondrosis.
(c) In this region of endochondral ossification, the tissue at B represents the first-formed bone, known as woven bone.
(d) In the growth plate of a long bone, hypertrophic chondrocytes are aligned in columns on only one side of the cartilage.

145 Incompetent forceps delivery might result in damage to the mandibular condyles, leading to ankylosis of the temporomandibular joint and interference with normal mandibular development. The resulting malformation, with a very small lower jaw, is termed micrognathia.

Tooth Development

146 (a) False. The early bell stage is reached at about the 14th week of development.
(b) False. The vestibular lamina lies buccal to the dental lamina.
(c) False. The combination would result in a molariform tooth.
(d) False. The stratum intermedium consists of a few layers of cells.
(e) False. The stratum intermedium is rich in alkaline phosphatase. It is the ameloblast cell layer that is rich in RNA.
(f) True. Some of the alveolar bone may also arise from the dental follicle.
(g) True. The cells also have many cell contacts and possess a relatively well-differentiated Golgi complex.
(h) True. Differentiation will occur only with a pore size greater than 2μm.
(i) True. Where the enamel cord meets the external enamel epithelium, a small invagination

termed the enamel navel may be seen.
(j) False. The dental papilla and dental follicle contain ectomesenchymal cells.

147 (a) Late cap stage. This is reached by about 12 weeks of development.
(b) A = stellate reticulum. B = external enamel epithelium. C = internal enamel epithelium. D = dental papilla. E = dental follicle (investing layer).
(c) Glycosaminoglycans.
(d) F = Cervical loop (a region of high mitotic activity).

148 (a) Late bell (appositional) stage.
(b) A = successional tooth germ. B = developing alveolus. C = external enamel epithelium. D = stellate reticulum. Its function is probably a mechanical one, protecting the underlying dental tissues against physical disturbance and thereby maintaining tooth shape. E = dental papilla.
(c) The lingual side is to the right, the side on which the permanent tooth develops in relation to its deciduous predecessor.

149 Hereditary ectodermal dysplasia affects ectodermally-derived structures. As is evident from the photographs, a variable number of teeth, both deciduous and permanent, fail to develop. Indeed, virtually all of the teeth may be absent. In addition, the teeth may have a conical or fang-shaped appearance. This especially applies to the maxillary incisors which may also be enlarged. Other epidermal appendages may be affected, and the patient may lack hair and sweat glands.

150 The structures arrowed in *Figure 137* are known as epithelial pearls (of Serres), and represent remnants of the dental lamina. In *Figure 136*, the mandibular third molar has failed to erupt. Note that the roots are fully formed. The cause of this condition is related to the presence of the overlying radiolucent area, which probably represents a dentigerous (eruption) cyst caused by proliferation and cyst formation from remnants of the dental lamina.

Enamel Development

151 (a) False. The cells are highly columnar and, depending on species, can be more than 40µm long.
(b) True. In addition, the nucleus migrates to the opposite (basal or proximal) and non-secretory end of the cell adjacent to the stratum intermedium.
(c) True. The bulk of the amelogenins is removed during enamel maturation.
(d) False. This explains why the cross-stiations are closer together at the enamel surface.
(e) False. Matrix vesicles are not present in enamel, and mineralisation probably extends from the adjacent and already mineralised dentine.
(f) True. This might explain why each ameloblast contributes to more than one enamel prism.
(g) False. Prismless enamel is related to the absence of Tomes process.
(h) True. Nasmyth's membrane merges with the overlying oral epithelium to provide an epithelial lined pathway for the erupting tooth.
(i) False. Enamel matrix is mineralised almost as soon as it is secreted.
(j) False. Their molecular weight is much lower—ie 25,000.

152 (a) A = stellate reticulum. B = stratum intermedium. C = ameloblast layer. D = enamel matrix. E = dentine matrix. F = odontoblast layer. G = dental papilla/pulp.
(b) The principal amino-acid of young enamel matrix is proline, that of dentine is glycine.
(c) Yes. It occurs in presecretory ameloblasts (ie pre-ameloblasts).

153 (a) A = ameloblast. B = Tomes process. C = developing enamel.
(b) Terminal bar apparatus.
(c) The presence of a Tomes process is responsible for the prismatic appearance of enamel, resulting in the sudden changes in crystallite orientation at prism boundaries. The absence of a Tomes process during the formation of surface enamel has been associated with prismless enamel in this region.

154 This 14-year-old patient is from a country/region where there are high levels of fluoride in the drinking water. This has resulted in toxic effects during the period of enamel formation of many of the teeth. The mottled appearance of the enamel is known as fluorosis and can occur when fluoride levels in the drinking water are in excess of 1 part per million. The enamel affected by fluorosis is hypocalcified but it is also acid-resistant. Fluorosis has to be distinguished from other defects in the enamel such as amelogenesis imperfecta.

Development of the Dentine and Pulp

155 (a) True. This explains why some oral biologists refer to the two tissues collectively as the pulpodentinal complex.
(b) False. Dentinogenesis precedes amelogenesis. Indeed, it is thought that the initially formed dentine has an inductive influence, resulting in the differentiation of ameloblasts from the preameloblasts of the internal enamel epithelium.
(c) True. Such collagen is sometimes referred to as von Korff fibres, fibres extending between the odontoblasts into the mantle dentine.
(d) False. The papilla is ectomesenchymal (neural crest) in origin.
(e) False. In the early stages of pulpal development, the ground substance has a high GAG content relative to that in the mature tooth. The GAG level increases until the time of eruption and then decreases. The chondroitin sulphates are the main GAG during development, with little hyaluronan. This balance is reversed in the mature pulp.
(f) False. Although nerves are present close to the tooth germ from the very earliest stages of development, they do not enter the dental papilla until later. The final pattern is not established until root formation is complete.
(g) False. The matrix vesicles arise from the processes of the odontoblast cells.
(h) False. Mineralisation commences after a thin layer of (unmineralised) predentine has been laid down. This layer may vary from 10µm – 40µm in thickness. Thereafter, mineralisation proceeds with dentine formation, a layer of predentine always remaining.
(i) True. The spherical pattern of mineralisation corresponds with the calcospherites in dentine.
(j) True. Dentinogenesis imperfecta is associated with 'opalescent' dentine and rapid obliteration of the pulp chambers and canals. There is often much attrition and the condition is generalised across all teeth in the dentition. The disease is not sex-linked and, when present in one parent, is transmitted by chance to about half the offspring.

156 (a) A = enamel matrix. B = dentine matrix. Unlike the adult condition, developing enamel matrix is retained in demineralised sections because of its higher organic content.
(b) The matrix (in part) of the first formed dentine, the mantle dentine, might be derived not from the odontoblasts but from von Korff fibres originating from subodontoblastic cells. These fibres lie perpendicular to the enamel–dentine junction. However, this is still contentious as, although pulpal fibroblasts secrete both type I and type III collagens, only type I collagen is found in the matrix of mantle dentine. In the circumpulpal dentine, the fibres run parallel with

this junction. In addition, the mantle dentine shows marked branching of the dentinal tubules because the early odontoblasts have many minor processes before the major odontoblast process becomes established. Mantle dentine may mineralise as the result of matrix vesicles, and may also be hypomineralised with respect to circumpulpal dentine.

(c) The basic process of root dentinogenesis does not differ fundamentally from coronal dentinogenesis. However, differences are seen in the early stages. Initial collagen deposition does not begin immediately against the basal lamina of the epithelial cells of the root sheath. The space between the initial collagen and the epithelial cells becomes filled with an amorphous ground substance and a fine, fibrillar, non-collagenous material that appears to be formed from the root sheath (and may thus be a form of enamel). These elements form a hyaline layer which is approximately 15µm thick. The initial collagen fibres deposited in the root lie approximately parallel to the cement–dentine junction. This contrasts with the mantle dentine in the crown, where the collagen fibres are deposited perpendicular to the enamel–dentine junction. Radicular odontoblasts differ slightly from those in the crown, developing several fine branches which loop in 'umbrella fashion'. This gives rise to a granular layer (of Tomes), although a large part of this is also thought to be due to the presence of many small, uncalcified, interglobular areas. The different character of peripheral radicular dentine presumably relates to the difference between the cells of the internal enamel epithelium (which in the crown will differentiate and continue as ameloblasts) and the cells of the root sheath (which lose their continuity soon after dentinogenesis has begun). The loss of continuity of the epithelial cells results in larger numbers of interglobular areas and possibly also in the incorporation of some epithelial remnants in the peripheral dentine. Root dentine forms at a slightly slower rate than coronal dentine. Its pattern of mineralisation is similar, although its initial calcospherites are smaller and its interglobular areas are more numerous. In general, mineralisation of root dentine proceeds as a continuation of that in the crown, although in multirooted teeth separate areas of mineralisation may occur.

157 A = polarised microscopy evidence of the pattern of calcospherites in circumpulpal dentine. B = mantle dentine, the first formed dentine which, in polarised light, shows a birefringence different from the circumpulpal dentine and thus indicating different collagen fibre orientations.

158 The presence of tubules indicates that both specimens are of dentine. In *Figure 143*, the small spherical protrusions represents calcospherites and we are therefore looking at the mineralising front of forming dentine at the pulpal surface. In *Figure 144*, the dentine surface exhibits large scooped-out areas (representing Howships lacunae), so that we are looking at a resorbing dentine surface.

159 Dens in dente means 'tooth within a tooth'. It results during tooth development either from the downward proliferation of a portion of the internal enamel epithelium of the enamel organ into the dental papilla or from retarded growth of part of the tooth germ. It presents on the fully erupted tooth as an extremely deep pit and most commonly affects the permanent maxillary lateral incisor. The full range of dental tissues (including cementum and bone from incorporation of tissue from the dental follicle) may be associated with the 'infolded' organ.

Development of the Periodontioum

160 (a) False. Root development commences some time after crown formation is complete (perhaps a period of some months).

(b) False. The epithelial root sheath comprises only the external and internal enamel epithelia.

(c) False. The internal enamel epithelial cells do not increase in size during induction of root

dentinogenesis.
(d) False. Cementoblasts arise from cells of the investing layer of the dental follicle.
(e) True. This differs from the situation in deciduous teeth and is relevant to theories of tooth eruption which implicate collagen fibre involvement.
(f) False. Mineralisation is linear.
(g) True. This layer of precementum is wider in cellular (secondary) cementum, which is formed at a faster rate compared with acellular cementum.
(h) False. It merges with the fibres of the developing periodontal ligament.
(i) True. Coronal cementum is found particularly in the cheek teeth of herbivorous mammals and in some teeth of continuous growth.
(j) False. Its growth occurs along paths of low vascularity.

161 A = dental papilla. B = epithelial root sheath. C = odontoblast layer in root. D = predentine. E = dentine. F = developing cementum. G = developing periodontal ligament. H = developing alveolar bone.

162 (a) A = cell of dental follicle. B = cell of epithelial root sheath. C = predentine. D = odontoblast.
(b) The epithelial root sheath helps map out the shape of the root, induces root dentine formation, and may secrete components into the first-formed cementum material.
(c) Cells of the epithelial root sheath form the epithelial rests present in the periodontal ligament. Under certain conditions, these 'rests' may become cystic.
(d) The predominant protein in predentine is type I collagen.

163 A = cementoblast layer. B = precementum. C = cementocytes being incorporated into matrix. D = Sharpey fibres of the periodontal ligament.

164 (a) Epithelial pearl. This comprises a localised mass of enamel, with a core of dentine, found on the root.
(b) It is thought that in the region affected, stellate reticulum and stratum intermedium develop between the internal and external epithelia of the root sheath. This provides the ability to form some enamel locally.

165 (a) Lateral root canal in ground section (in *Figure 151a*) and in root filled tooth (in *Figure 151b*).
(b) Although the aetiology is not known for certain, it is likely that the epithelial root sheath grows around an aberrent blood vessel, leaving a lateral channel which forms a lateral root canal.
(c) As lateral root canals may occur in the inter-radicular regions, gingival recession may lead to their exposure in the oral cavity with the possibility of pain and pulpal inflammation resulting.

Development of the Dentitions

166 (a) False. It is the second molar which usually erupts between 21 and 30 months after birth. The deciduous maxillary first molar erupts between 12 and 16 months after birth.
(b) True. The maxillary second molar also erupts at about this time.
(c) False. The permanent canines commence calcification at 4 – 5 months after birth.
(d) True. Calcification of this tooth is first evident 3 – 4 months after birth.
(e) False. The root is usually completed at 9 – 10 years of age, approximately 3 years after the tooth has erupted.
(f) True. A 'mixed' dentition describes the situation where there are both deciduous and

permanent teeth in the mouth at the same time.
(g) False. The maxillary and mandibular gum pads rarely come into occlusion, the space between them being occupied by the tongue.
(h) True. The edge-to-edge bite results from greater forward growth of the mandible compared with the maxilla.
(i) False. At the time when the permanent teeth are beginning to erupt (6 years), the deciduous teeth appear spaced because of growth of the jaws.
(j) True. The first molars take up their 'normal' adult relationship once the deciduous second molars are shed.
(k) True, although mesial drift has been ascribed to other factors (eg contraction through the transseptal fibre system).
(l) False. The permanent teeth show gubernacular canals.
(m) False. The cementoclasts/dentinoclasts/odontoclasts are, like the osteoclasts, derived from circulating blood cells of the monocyte/macrophage lineage, and all have the same basic ultrastructural features.
(n) True. Although, with time, the junctional epithelium may be replaced by the oral epithelium and thereby loses its association with the reduced enamel epithelium.
(o) True. It is thus possible that the forces responsible for the eruptive mechanism remain even when the tooth has reached its functional position.
(p) False. Although all the permanent incisors, the permanent first molars, and possibly the mandibular canines have erupted by the age of 9 years, the permanent maxillary canines and second molars would be unerupted.
(q) False. The main phase of eruption begins with the development of the root. However, both clinical and experimental studies indicate that rootless teeth can erupt and that a tractional force acting through the periodontal ligament (collagen fibres) is not responsible for eruption.
(r) False. Root resection experiments suggest that the eruptive force is generated within the periodontal ligament (see (q) above).
(s) False. The periodontal vasculature, consisting mainly of capillaries, shows increased vascular pressures with hypotensive agents and there associated increased eruption-like movements.
(t) True. However, the features of periodontal fibroblasts in culture are remarkably different from the fibroblasts *in vivo*.

167 The dental age is 5 years.

168 The dental age is 9 years

169 The deciduous dentition is fully erupted and the roots fully developed, giving a minimum age of 3 years. The crowns of the mandibular permanent incisors and first molars are complete and root development has just commenced, giving a dental age of about 4 years.

170 The permanent incisors and first permanent molars have erupted. Root development on the first molars is almost complete, giving a minimum age of 9 years. The crown of the mandibular second permanent molar is complete and root development is just commencing. The mandibular permanent canine is just erupting. These factors suggest the dental age of the skull is about 9 years.

171 (a) The mandibular right first permanent molar is buried within the jaw and the space it normally occupies within the dental arch has been reduced by tilting of the adjacent teeth. The maxillary right first permanent molar is similarly, but less, affected.
(b) During their development, either before or soon after they had erupted into the mouth, the affected first molar teeth probably became ankylosed to the bone of the socket. They were then

unable to erupt any further and, with subsequent growth of the jaws and alveolar processes, they gradually became submerged and incorporated into the bone of the jaws. They may then be referred to as 'submerged teeth'. The mandibular tooth probably became ankylosed earlier than the maxillary tooth, as the second molar has erupted more mesially. The reason for the original ankylosis is not understood. The tooth commonly affected is the second deciduous molar.

172 (a) A = erupting permanent tooth. B = gubernacular canalu. C = resorbing root of deciduous tooth.

(b) The permanent mandibular canine tooth would initially develop below, and on the lingual aspect of, the deciduous mandibular canine. Once the permanent tooth starts to erupt it is associated with resorption of the deciduous canine on the lingual surface of its root. With subsequent movement and relocation of the teeth in the growing jaws, the permanent tooth comes to lie directly beneath the deciduous tooth and resorption occurs from the apex. An isolated tooth which shows evidence of resorption can be readily distinguished from roots showing fractures or incomplete development. For incomplete root development, the apical root canal is relatively large (open) and its margin has a smooth knife-edge. For a resorbing root, the surface is rough and irregular. For a fractured root, the surface is smooth and the pulp opening is usually narrow.

(c) As the tooth erupts, the outer cells of the reduced enamel epithelium (the vestige of the enamel organ which forms a thin layer over the crown of the erupting tooth) proliferate into the connective tissue between the tooth and the oral epithelium. These proliferating epithelial cells may secrete enzymes which degrade the collagen. In addition, the fibroblasts in the connective tissue overlying the erupting tooth cease fibrillogenesis and, as judged by the abundance of intracellular collagen profiles, they actively take up extracellular material. Eventually, the fibroblasts themselves degenerate (the nuclei becoming pyknotic). The reduced enamel epithelium cells may also aid eruption by removing the breakdown products resulting from the resorption of the overlying connective tissue. Experiments have shown that the dental follicle has some role to play in the production of an eruptive pathway in the tissues above the erupting tooth.

As the tooth approaches the oral epithelium, the cells of the outer layer of the reduced enamel epithelium and the basal cells of the oral epithelium unite. The epithelium covering the tip of the tooth then degenerates at its centre, enabling the crown to emerge through an epithelial-lined pathway into the oral cavity. Further emergence of the tooth results from active eruptive movements and passive separation of the oral epithelium from the crown surface. With continued eruption, the reduced enamel epithelium becomes the initial junctional epithelium, forming a seal between the oral environment above and the periodontal connective tissues below.

(d) That the periodontal ligament and its precursor, the dental follicle, is the source of the force(s) of eruption is well-documented. However, the force(s) does not need to be tractional, acting through the periodontal collagen by way of their attachments into the root of the tooth. There have been several clinical observations that rootless teeth erupt. Furthermore, production of rootless teeth by irradiation or surgery does not prevent eruption. Some permanent teeth also erupt into the mouth in the absence of a well-organised, fibrous network in the periodontal ligament and experiments with lathyrogens (which disrupt the collagen by specifically affecting the formation of collagen crosslinks) are also without effect on eruption (provided the tooth is maintained free of the bite to avoid the influence of trauma on the weakened periodontal ligament).

173 Although the teeth are present and the roots fully formed, the teeth have all failed to erupt (and are also malaligned). This is characteristic of a rare genetic abnormality known as cleidocranial dysostosis. The reason for the lack of eruption is not known, although the biochemistry of the connective tissue is affected in this disorder.

174 Delayed eruption of teeth may be caused by many factors, although most are local rather than systemic. Amongst the various structures/local conditions which could prevent eruption are: adjacent unerupted teeth, or teeth with unusual angulations; crowded dentitions; unresorbed deciduous teeth or retained tooth fragments; supernumerary teeth; malpositioning of the erupting tooth itself (including abnormal location for its initial development); presence of dental pathologies (eg eruption cysts); resistance provided by overlying soft tissues (which might involve failure to resorb the overlying tissues to produce an eruptive pathway); early loss of a deciduous tooth with drifting of adjacent teeth to block the eruptive pathway.

175 Between the ages of 6 and 13 years, the dentition is said to be 'mixed', comprising both deciduous and permanent teeth. The first molars are the first of the permanent teeth to erupt. Initially, they have a cusp-to-cusp relationship (the flush terminal plane) which is governed by the position of the deciduous second molars. The first permanent molars take up their 'normal' adult relationship once the deciduous second molars are shed. The permanent incisors erupt between the ages of 6 and 9 years. Since the permanent incisors are much larger than their deciduous predecessors, they are accommodated into the dental arches, not just by the utilisation of the space left by the deciduous incisors, but also by lateral growth of the alveolar arches and the greater proclination of the permanent incisors. Frequently, when the permanent incisors erupt, they fan out (incline distally) so that there may be a significant diastema between the central incisors. This appearance has been termed the 'ugly duckling' stage, the diastema usually closing following eruption of the permanent canines. The canines and premolars, which usually erupt between the ages of 9 and 12 years, are readily accommodated into the dental arches, since the combined mesiodistal dimensions of the deciduous predecessors are usually greater than for the permanent canines and premolars. Once all the deciduous teeth are shed, the occlusion appears similar to that in the adult and space for the permanent molar teeth is provided by continued growth of the mandible and maxilla.

Comparative Dental Anatomy

176 (a) True. This ridge of bone is a site for muscle attachment and corresponds to the genial (mental spines in humans).
(b) False. The rabbit has some deciduous incisors and molars.
(c) False. In the mandible the first permanent molar is the carnassial tooth.
(d) False. There are only two permanent maxillary molars.
(e) True. The permanent teeth erupt between four and seven months.
(f) True. Four main cusps can be distinguished in each molar tooth, although each main cusp has numerous accessory cusplets.
(g) True. The lower anterior eight teeth bite against a horny pad in the upper jaw which lacks anterior teeth.
(h) False. All mandibular molars in apes have five cusps.
(i) True. The teeth have long crowns and short roots to allow for the considerable attrition resulting from their herbivorous diet.
(j) True. The marmosets (Callithricidae) have only two molars.
(k) True. The upper molars have three roots, the lower molars two roots.
(l) True. The darker areas seen within the crescent-shaped regions represent secondary dentine.
(m) True. The mandibular first premolars also have three roots.
(n) False. A sagittal crest is always found in male gorillas but less frequently in females.

(o) True. A small diastema separates this tooth from the mandibular canine in order to accommodate the maxillary canine.
(p) False. The canines did project above the occlusal plane and a diastema is present between the maxillary lateral incisor and canine.
(q) False. The cranial capacity is 400 – 500cm^3.
(r) False. 'Nutcracker Man' refers to *Australopithecus robustus*.
(s) True. In *Homo sapiens*, the broadest part of the skull is towards the parietal eminences.
(t) False. Growth periods in australopithecines were markedly abbreviated relative to those of modern man.

177 (a) Rat.
(b) I 1/1 C 0/0 PM 0/0 M 3/3.
(c) No.
(d) Approximately 400µm/day.
(e) Iron pigment (the function of which is unknown).
(f) No. The tip of the cusps are enamel-free.
(g) The condyle is elongated anteroposteriorly.

178 The large canines and blade-like cheek teeth indicate the skull is of a carnivore.
The dental formula is I3/3 C1/1 PM 4/4 M2/3
The skull is therefore likely to belong to a member of the dog family (Canidae).

179 (a) Old World Monkeys (Cercopithecidae).
(b) DI 2/2 C 1/1 DM 2/2.
I 2/2 C 1/1 PM 2/2 M 3/3.
(c) This tooth is a specialised sectorial tooth.
(d) The teeth are bilophodont and increase in size from before backwards. The third molar has an extra, fifth cusp.

180 The dental formula is I2/2 C1/1 PM2/2 M3/3
There is a clear disproportion in size between the anterior and posterior teeth. Indeed, the cheek teeth are very large. The canines are small and there is no evidence of a diastema. The skull can be considered as belonging to the group *Australopithecus robustus/boisei*.

181 (a) *Homo erectus* (from Kenya).
(b) From about 1.8 – 0.3 million years ago.
(c) 850 – 1050cm^3.
(d) No.
(e) The teeth of *Homo erectus* were larger, the maxillary central incisors were more shovel-shaped, the canines were more robust, cinguli were present around the cheek teeth and the second and third mandibular molars tended to possess five cusps.
(f) Taurodont. The pulp chamber extending well into the roots.

Index

All numbers refer to question/answer numbers.

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