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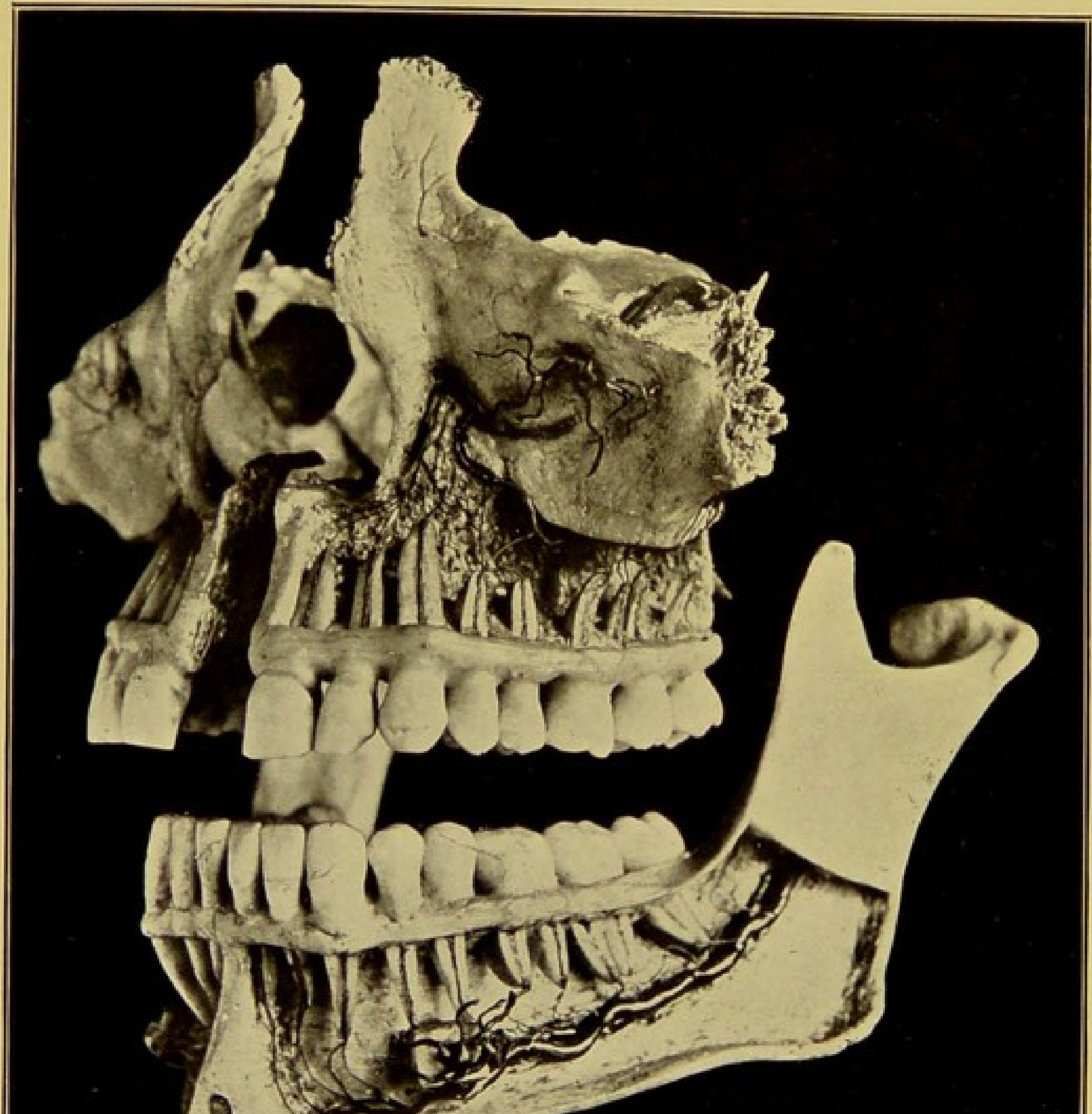
PLATE I.



FRONTISPIECE.

THE

NAKED-EYE ANATOMY

OF THE

HUMAN TEETH.

BY

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BRISTOL: JOHN WRIGHT & CO.

LONDON: SIMPKIN, MARSHALL, HAMILTON, KENT, & CO., LTD.

1905

TO

THE MEMORY OF

THE LATE

ARTHUR JULIUS POLLOCK, M.D.,

SOMETIME

SENIOR PHYSICIAN

TO

CHARING CROSS HOSPITAL.

PREFACE.

The greater part of this treatise was written ten years ago, and was intended merely as a preface to certain observations on Dental Physiology upon which I was then engaged. The scope of these latter has widened to such an extent, that I have decided to publish these anatomical notes separately, otherwise the limits desirable in a text-book intended primarily for students would be exceeded.

In the descriptions of the teeth considerable restraint has been exercised, my desire being to indicate as briefly as possible their essential features rather than to demonstrate with polysyllabic phraseology to what extent the subject can be elaborated.

Photographs were originally prepared to illustrate the teeth, but these were rejected in favour of the outline drawings, because the student is strongly advised to obtain actual teeth to compare with the descriptions ; and if he does this he will find the outline drawings more helpful than photographs.

Embryology, physiology, histology, and morphology have been excluded entirely, as it would have been difficult otherwise to decide where the line should be drawn.

I desire to express my thanks to Mr. J. F. Colyer, the distinguished Curator of the Museum of the Odontological Society of Great Britain, for kind permission and facilities to photograph the specimens illustrating the development of the teeth; also to Messrs. Longmans, Green & Co., for their kind permission to reproduce from *Gray's Anatomy* the illustrations in Chapters VII, IX, X.

THOS. E. CONSTANT.

20, RAMSHILL ROAD,
SCARBOROUGH,
December 1904.

CONTENTS.

LIST OF ILLUSTRATIONS.

PLATES.

DIAGRAMS.

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THE NAKED-EYE ANATOMY OF THE HUMAN TEETH.

CHAPTER I.

INTRODUCTORY.

HUMAN TEETH may be defined as special organs developed from the tissues of the jaws. Their chief function is to assist in the process of mastication, to the perfect performance of which they are essential. They subserve this purpose by affording two opposed surfaces of intensely hard material, between which food is comminuted and crushed in such a manner as to admit of its insalivation and to facilitate its digestion.

The number of teeth normally developed is fifty-two. Twenty of these are classified as **temporary** and the remaining thirty-two as **permanent** teeth. This distinction is justified by the fact that the temporary teeth fulfil their functions during the years of early childhood and are then replaced by permanent successors, which are intended to bear the brunt of mastication through the greater part of a lifetime.

The late Professor Owen employed the term **diphyodont** to distinguish those mammals which thus develop two sets of teeth from those which develop one set only.

As the teeth of some mammals are all alike in general outline, while others have teeth which vary in size and form in different parts of the mouth, he also employed the terms **homodont** and **heterodont** to distinguish the two classes. Man—the *genus homo*—is therefore, according to this classification, a diphyodont heterodont mammal.

Although the teeth of the same individual differ so much one from another that it is possible to distinguish not only the various members of the same set, but also to be able to state the position in the jaws that any tooth of normal shape should occupy, yet all present certain common characteristics (*Plate II*). Thus, every tooth has a **crown**, a **neck**, a **root** (consisting of one or more **fangs**), and a central chamber extending through the root and neck into the crown. The portion of this chamber which extends through the fang, is termed the **pulp-canal**, the remainder of it constituting the **pulp-chamber.**

In a fully developed tooth, which occupies its normal position, the crown is that portion which projects beyond the gum into the cavity of the mouth, the root that part which is embedded in the jaw, and the neck is at the junction of the crown and the root.

The crown consists externally of an extremely hard and inelastic material which, probably on account of its smooth and glistening surface, is termed **enamel**. This is thickest over those parts of the tooth furthest removed from the root ; in other words, in those situations where it is the most liable to attrition. The enamel of the temporary teeth is uniformly milk-white in colour, but that of the permanent teeth varies with the individual from milk-white to yellow or bluish-grey. It also varies in colour in different parts of the same teeth, and the various teeth of the same individual may (in fact generally do) present varying shades of colour.

Covering the enamel is a thin layer of horny material

PLATE II.

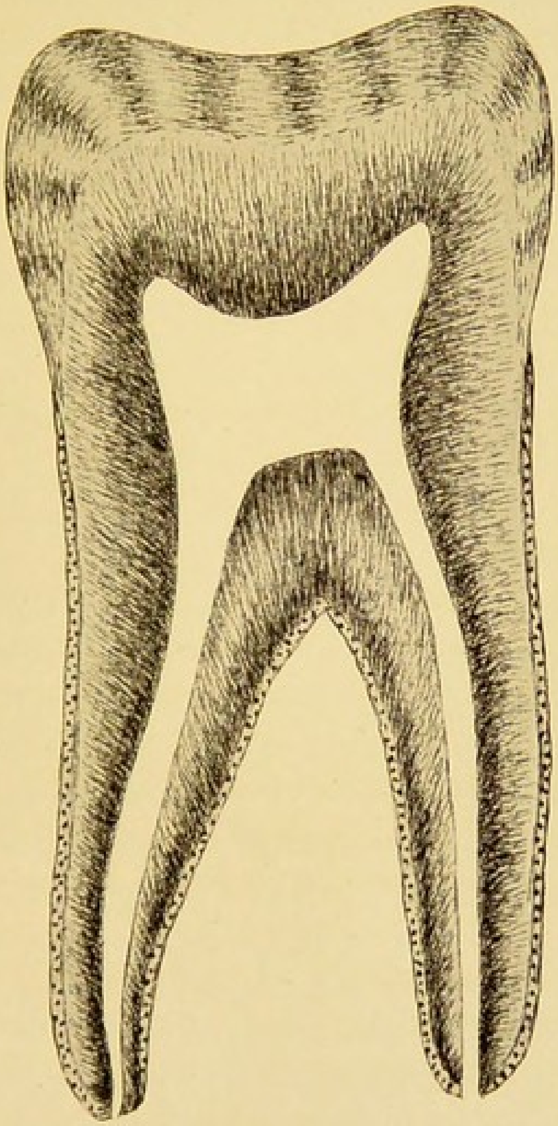

Diagram of the Hard Tissues of a Tooth.—
Vertical Section.

termed **Nasmyth's Membrane.** This is such a thin veneer that it is indistinguishable to the naked eye, but can be demonstrated by treating the enamel with acids.

Beneath the enamel lies the **dentine,** a substance of which the major portion of the tooth is composed. To the naked eye the dentine has much the appearance of bone, but the microscope reveals that it has a vastly different structure. Continuous with the dentine of the crown is that which helps to form the root. Covering the dentine of the root, in much the same way as enamel covers that of the crown, is the **cementum** (*crusta petrosa*). This is true bone. Unlike the enamel, the cementum cannot be distinguished from the dentine with the naked eye, and the older anatomists were ignorant of its existence.

In the centre of the dentine, both of the root and of the crown, is the **pulp cavity** (comprising the pulp chamber and pulp canal), which roughly resembles the shape of the whole tooth and terminates at the extremity of the root in a foramen, the **apical foramen,** which allows of the passage of vessels and nerves to the fleshy material which fills the cavity when the tooth is in its natural state. This fleshy material is the **pulp,** the extreme sensitiveness of which, under certain conditions has earned for it the title of the '*nerve.*'

The cementum is invested by a membrane somewhat resembling the periosteum of bone. This is the **dental periosteum,*** which forms the connecting bond between the root of the tooth and the bony socket, in which it is implanted in a manner that will be presently described.

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* This structure has been variously styled by dental writers the *peridental membrane*, the *pericemental membrane*, the *pericementum*, the *alveolo-dental periosteum*, and the *alveolo-dental ligament*.

Chapter II.

THE TEMPORARY TEETH.

THE **temporary** (*deciduous*) teeth are twenty in number. Ten are developed in the upper and ten in the lower jaw. When their development is complete, they form the two rows of teeth that we find in the mouths of children from two to six years of age. The accompanying illustration (*Plate III.—A*) is of a cast of the upper row of teeth of a child four years of age. By reference it will be seen that the ten teeth consist of five pairs. In the centre of the row is a pair of flattened chisel-shaped teeth termed the **central incisors.** The teeth next to these, which somewhat resemble them in shape but are much smaller, are termed the **lateral incisors,** and next to these are the sharp pointed teeth termed the **canines** (*cuspids*). Next come somewhat cubical flattened teeth, the **first molars,** and the extremities of the row are occupied by the **second molars,** which somewhat resemble the first molars in general outline, but are much larger. (*Plate III.—B*) is an illustration of a cast of the lower row of teeth of the same child. It will be seen that the general arrangement of the teeth is the same as in the upper row, that is to say there are five pairs. Like the upper teeth these are termed, commencing from the central pair, central incisors, lateral incisors, canines, and first and second molars.

The most striking difference in the corresponding teeth, in the upper and lower rows, is that the lower

PLATE III.

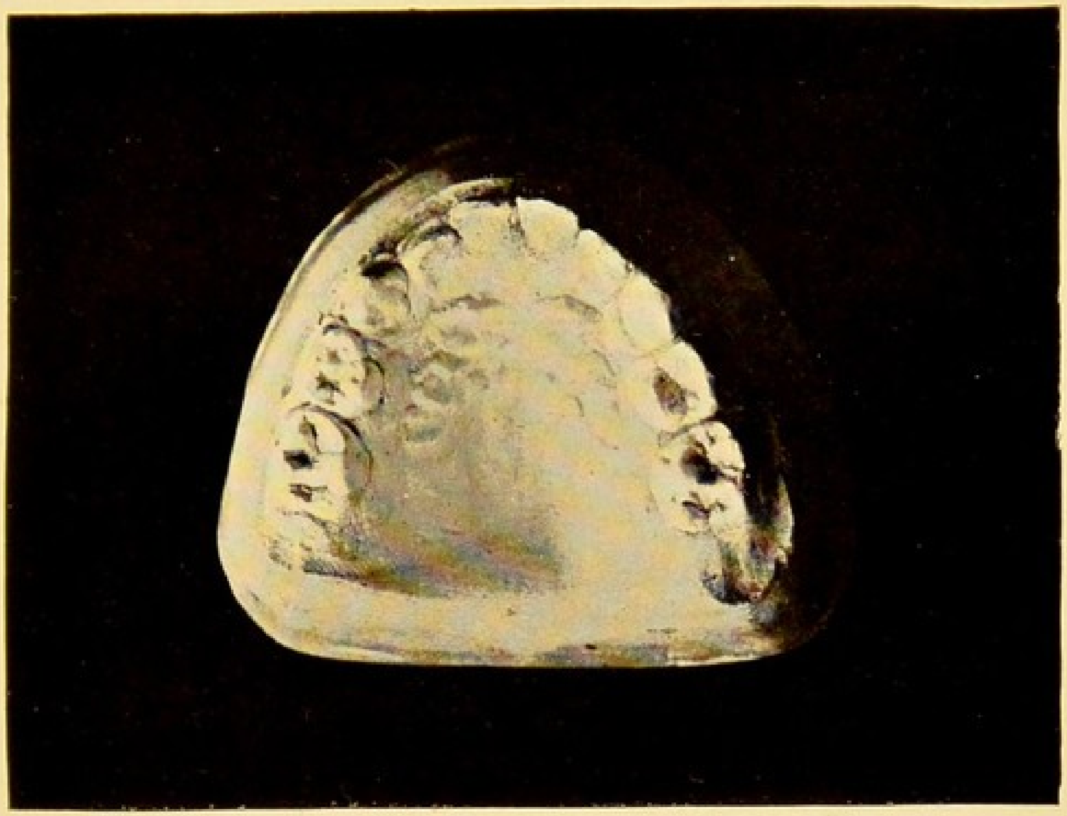


Fig. A.

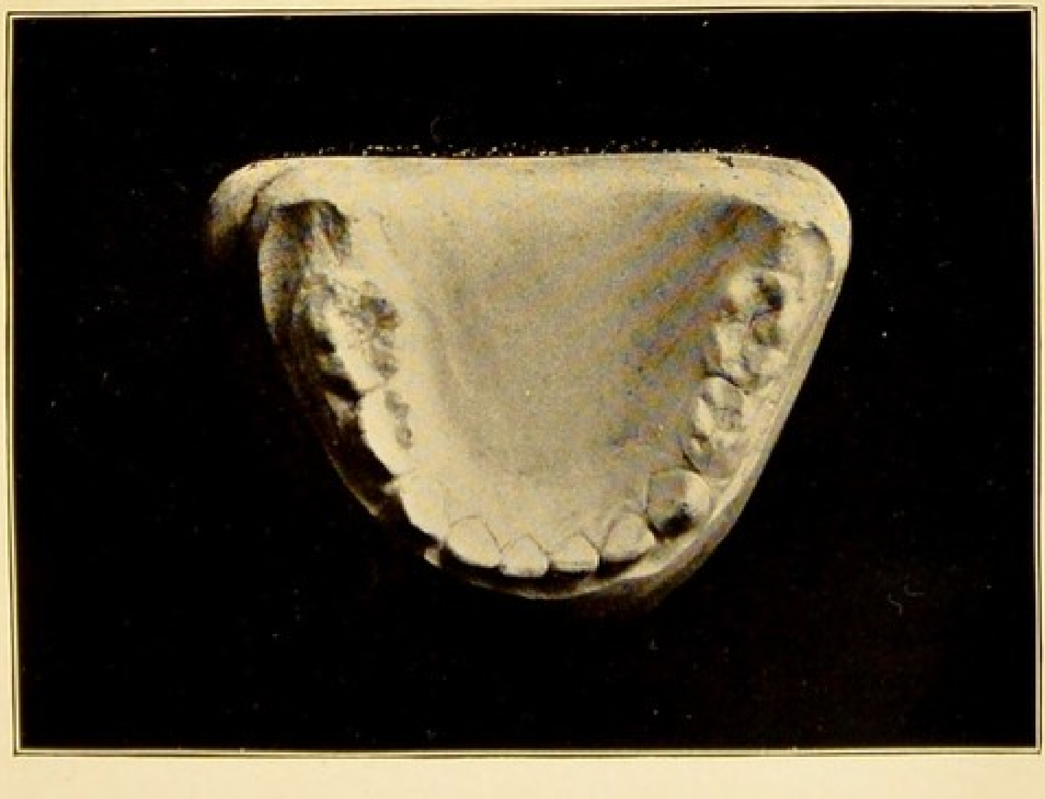


Fig. B.

incisors are much smaller than the upper. The reason for this difference will be evident later on, when we come to consider the manner in which the upper and lower teeth antagonise. It is perhaps scarcely necessary to remark that only the crowns of the teeth are shown in the illustrations to which attention has been drawn, the roots being, as they are in nature, completely hidden from view.

For the sake of brevity, the deciduous dentition is usually expressed by the following **formula**—

$$I\tfrac{2}{2}\ C\tfrac{1}{1}\ M\tfrac{2}{2} = 20,$$

which is a shorthand method of stating that there are in each lateral half of the jaws, above and below, two incisor teeth ($I\tfrac{2}{2}$), one canine ($C\tfrac{1}{1}$), and two molars ($M\tfrac{2}{2}$), and although this obviously does not represent twenty teeth, the formula is completed as $= 20$, to indicate the fact that only one half of the full number of the teeth is enumerated on one side of the formula. It would in the author's opinion be much better if the formula were written—

$$2\,(I\tfrac{2}{2}\ C\tfrac{1}{1}\ M\tfrac{2}{2}) = 20,$$

as it would add but little to the formula, and make it much easier for the student to understand.

During the early months of infancy the developing teeth lie concealed in the substance of the jaws. Any appearance of teeth in the mouth of an infant younger than seven months must be regarded as premature. The natural food of a very young infant being its mother's milk, the presence of teeth within its mouth is not only unnecessary for the child, but would probably be extremely discomforting to the mother.

It is worthy of notice that the eruption of the temporary incisor teeth is stated by the earlier dental writers to occur at a later period of life than is found to be the case at the present day. The late Sir John Tomes described the crowns of the incisor teeth of an eight months' infant as still being contained within the crypts in which they were developed. This would not be the case with the average eight months' infant of to-day, as the author has ascertained by careful enquiry extending over several years.

About the seventh, eighth, or early in the ninth month —for the time varies considerably even in health—the first of the temporary teeth **erupt,** or to use the more popular expression, are '*cut.*' The lower central incisors are usually the first to appear, and these are followed, at intervals of a few weeks, by the upper central and lateral incisors. Then follow the lower lateral incisors, then the first molars in the upper and lower jaws, then the canines, and finally the second molars ; the temporary dentition being complete when the child is two years old or thereabouts.

As most mothers know, the **dates of eruption** of the temporary teeth vary considerably, but the following table may be accepted as a fair average :—

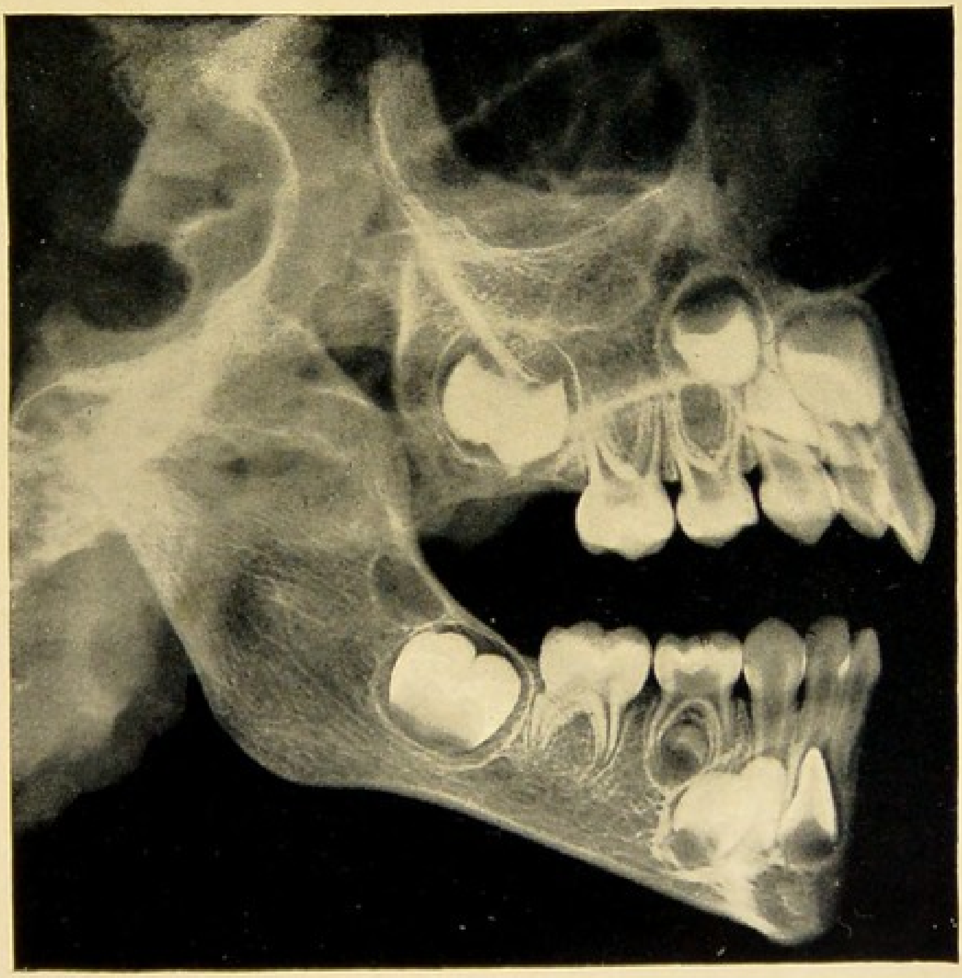
MONTHS.	
7— 8.	The lower central incisors
9—10.	Upper central and lateral incisors
11.	Lower lateral incisors
14—15.	Upper and lower first molars
17—18.	Upper and lower canines
19—24.	Upper and lower second molars.

From the above table it may be seen that the first molars erupt before the canines—spaces being thus left between the lateral incisors and the first molars—which spaces are subsequently filled up by the canines. Certain constitutional disorders retard the eruption of the temporary teeth ; but the consideration of pathological conditions does not come within the province of this treatise.

SYMINGTON AND RANKIN'S SKIAGRAMS.

SPECIMEN ILLUSTRATION.

FIG. I. ON PLATE V.



RIGHT SIDE OF GIRL THREE YEARS OLD.

In ordinary anatomical descriptions it is usual to describe the body as standing erect, with the palmar surfaces of the hands to the front. A vertical median line is assumed dividing the body into lateral halves. This is useful for the ordinary purposes of description, as it enables the surfaces of the bones of the limbs, etc., to be described as anterior, posterior, internal (looking towards the imaginary mesial line), and external. Unfortunately this simplicity of nomenclature is impossible for the surfaces of the crowns of the teeth, which curve out from the centre line of the dental arches in such a manner that the surface that is anterior in the central teeth becomes, by a gentle gradation, external in the molar region. It has been necessary therefore to supply a special nomenclature, and as the authorities have not been unanimous as to the form it should take, slight differences in the terms used to express the same parts of the teeth are not unusual. The most satisfactory method of distinction is the following.

That surface of the crowns of both the upper and lower teeth which is directed towards the tongue is termed the **lingual** surface. Some authorities term the lingual surface of the upper teeth the *palatal*, but this distinction is superfluous. That surface of the molar teeth (and, in the case of the permanent teeth presently to be described, of the pre-molar teeth also), which is turned towards the cheek is termed **buccal**, and that surface of the canine and incisor teeth which is turned towards the lips is termed **labial.** The surfaces of the crowns of the teeth which are contiguous to the neighbouring teeth are termed **interstitial,** and those interstitial surfaces which look towards the median line of the dental arches (or would do so if those arches were straightened out), are termed **mesial,** and the others **distal.** Thus the mesial surfaces of the central incisors, upper and lower, are contiguous, but in every other case a mesial surface is in contact with a distal; the distal surfaces of the second molars, in the case of the deciduous teeth, being the terminals of the dental arches.

That surface of the molar teeth, (and in the case of the permanent "set" of the pre-molar teeth also) that occludes with the teeth of the opposite jaw is variously termed the **occlusal**, *occluding*, or *grinding* surface; while the edges of the incisors and canines that correspond to this surface are called the **cutting edges.**

We are now in a position to consider the deciduous teeth in detail.

THE UPPER CENTRAL INCISOR has a root with a single fang. Its **crown** is roughly wedge-shaped, the cutting edge of the tooth forming the thin edge of the wedge. It presents for examination four surfaces and two angles.

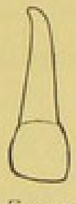


Fig. 1.

The *labial* surface (*Fig.* 1) is convex from above downwards, and from side to side. It has four borders or margins—an inferior, which forms the cutting edge, a cervical (gingival or superior), a mesial, and a distal. The mesial margin is convex, and is rather longer than the distal, and, in consequence, the inferior margin, or cutting edge, is not exactly at right angles to the long axis of the tooth, but forms a more acute angle with the mesial than with the distal margin. The distal margin is also convex, more so than the mesial. Both the mesial and distal converge to form the cervical margin. This margin is convex, and is well marked, the enamel being quite thick, and terminating abruptly, the result being that the neck of the tooth appears very constricted; and in this, as will be seen later, it differs markedly from the permanent central incisor teeth. The highest point of the convexity of the cervical margin of the labial surface is nearer the mesial than the distal border.

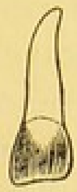


Fig. 2.

The *lingual* surface (*Fig.* 2) of the crown is concave. It has four borders or margins, an inferior (the cutting edge of the tooth), a mesial, a distal, and a cervical. The mesial and distal margins are ridges that form the edges of the concavity of the lingual surface. They are convex, and rapidly converge to form the cervical border of the surface. The cervical border is a well-marked ridge terminating abruptly above in a convex margin. Sometimes the ridge that forms the cervical border of the lingual surface encroaches considerably upon that surface. This forms the lingual tubercle. In a newly erupted tooth, the cutting edge forms the inferior border of both the lingual and labial surfaces; but later, as the tooth becomes worn by attrition (chiefly at the expense of its lingual surface), the cutting edge becomes a flattened surface that divides the inferior borders of the labial and lingual surfaces.

Fig. 3.

The *mesial* surface is V-shaped (*Fig.* 3). It has three borders, the labial and lingual (which are also the mesial borders of the labial and lingual surfaces respectively), and a cervical. The labial and lingual margins form the sides of the V, the point at which they meet being the mesial angle of the crown. The cervical or gingival margin is concave. The mesial surface is usually convex, but is sometimes flattened, or even tends to concavity towards its gingival margin. Where it does this, the mesial and distal margins of this surface form distinct ridges.

The *distal* surface is also V-shaped and is always convex. It has three borders, labial and lingual (which are the distal of the lingual and labial surfaces respectively), and a cervical. The labial and lingual converge to form the distal angle of the crown. The cervical is concave.

The cervical margins of the four surfaces of the crown are sometimes described together as the *gingival line.* This line is in all the teeth the demarcation between the root and the crown, and marks the line of meeting of the cementum of the root with the enamel of the crown.

In the case of all the incisor teeth, the junction of the cutting edge with the mesial and distal surfaces forms the mesial and distal angles of the crown respectively.

The **root** of the temporary central incisor is conical in shape, the apex of the cone being the extremity of the root; the gingival line above described being the outline of its base. A transverse section of the root, immediately above the upper limit of the gingival line, and at any point between that and the apex, shows an almost circular outline. The root is usually straight, but occasionally curves in its apical third towards the mesial side. It tapers gradually and uniformly from the neck to the apex, and, as the enamel of the crown ends abruptly in a thick margin at the gingival line, the neck of the tooth appears considerably constricted. In this particular, the temporary incisors differ markedly from their permanent successors. The root of the temporary central incisor is about one and a half times as long as the crown.

Fig. 4.

THE UPPER LATERAL INCISOR closely resembles the central incisor in general outline (*Fig.* 4). The chief point in which it differs is that the **crown** of the lateral is considerably less in its mesio-distal measurement, this difference being sufficiently marked to easily distinguish the lateral from the central incisor.

Another difference is, that the concavity of the mesial surface towards the cervical margin is more marked in the case of the lateral than of the central incisor.

The **root** on transverse section shows an oval outline, with considerable mesio-distal flattening, the labio-lingual diameter being the longest.

The Upper Canine (*Cuspid* or *Eye Tooth*) has also a root with a single fang.

Its **crown** viewed laterally is roughly wedge-shaped, but, when looking upon its labial or lingual surface, the cutting edge is seen to be prolonged downwards into a well marked point or cusp, a peculiarity which gives the tooth its name. It presents for examination four surfaces and two angles.

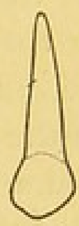


Fig. 5.

The *labial* surface (*Fig.* 5) is convex from side to side, and from above downwards, the convexity in both directions being more marked than that of the corresponding surface of the central and lateral incisor teeth just described. It has four margins. The mesial and the distal are slightly convex, and converge rapidly to form the superior or cervical margin, which forms a well marked curve, with its convexity towards the root. The highest point of the convexity of the cervical margin is, generally, slightly nearer the mesial than the distal margin. The inferior margin or cutting edge is, as before mentioned, prolonged downwards to a well marked point or cusp. This cusp in a newly erupted tooth forms a somewhat sharp point, much sharper than the corresponding cusp of the permanent canine. It is not quite in the centre, but rather nearer the mesial extremity of the margin. Some writers describe the cutting edge as two distinct margins, a mesial incisive and a distal incisive.

The most marked convexity of the labial surface is from the point of the cusp to the highest point of the cervical margin, this line being sometimes marked by a distinct ridge, the most prominent part of this being just below the cervical margin. When this ridge exists, which is not very often in the case of the temporary teeth, in its lower third it separates two depressions, the labial grooves.

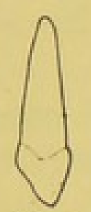


Fig. 6.

The *mesial* and *distal surfaces* (*Fig.* 6) are both V-shaped. Their planes are convergent towards the lingual side, the result being that the upper part of the lingual surface of the crown is considerably narrower than the upper part of the labial surface. They have three margins, a cervical (gingival or superior), a labial, and a lingual. The labial and lingual margins form the arms of the V, and converge below to form the mesial and distal angles of the crown respectively. The labial margins of the mesial and distal surfaces correspond to the mesial and distal of the labial surface respectively; they are, in fact, the same margins viewed laterally. Towards their upper extremities, the labial and lingual margins of the mesial and distal surfaces converge slightly; that is to say, the upper arms of the V turn in towards each other, where they meet the cervical margin. This will be understood by reference to the diagram illustrating the mesial surface (*Fig.* 6). The cervical margin is also V shaped, the point of the V being directed towards the cutting edge of the tooth. The extent of the surface enclosed between the labial, lingual, and cervical margins of the mesial and distal surfaces varies with the slope of the cutting edge of individual teeth.

Fig. 7

The *lingual* surface (*Fig.* 7) has a similar outline to the labial, but is narrower above, owing to the converging planes of the mesial and distal surfaces. It is slightly concave as a whole, the concavity, however, being encroached upon by two prominences, one extending upwards from the cusp, the other downwards from the cervical margin. It has four margins, the inferior, or cutting edge, which is the cutting edge of the labial surface viewed from behind, the mesial, distal, and cervical. The mesial and distal margins form the the ridges which bound the concavity. These ridges become more pronounced where they meet to form the lingual tubercle, the upper edge of which forms the cervical margin. The lingual tubercle is seldom so pronounced in the temporary teeth as in the case of their permanent successors.

The **root** of the canine tooth is longer than the roots of the incisors. It tapers gradually from the neck to the apex. On transverse section near the neck it shows an oval outline, the longest diameter of the oval being the labio-lingual, and its greatest transverse measurement being much nearer the labial than the lingual side. Towards the apex, the transverse section becomes gradually more circular in outline.

THE UPPER FIRST MOLAR has a root with three fangs.

Its **crown** is somewhat cubical, having in fact, the appearance of a cube with one angle, the mesio-lingual truncated. It presents for examination five surfaces.

The *occlusal* or *grinding* surface (*Fig.* 8) would be roughly quadrilateral, except for the rounding off of its mesio-lingual angle. It presents for examination three cusps, a mesio-buccal, a disto-buccal, and a lingual, separated by two grooves, the mesio-distal and the buccal. The surface has four margins. The buccal margin is convex, particularly towards its mesial extremity. The distal

Fig. 8.

margin, which forms a right angle with the buccal, is slightly convex, the mesial margin which forms an acute angle with the buccal, is nearly straight, except where it rounds off at its extremities to meet the lingual and buccal margins. The lingual margin is markedly convex. The occluding surface is unequally divided by the mesio-distal groove, which runs across from the mesial to the distal margins, dividing the mesio- and disto-buccal cusps from the lingual. The mesio-buccal cusp is divided from the disto-buccal by the buccal groove, at a point which is slightly nearer the distal than the mesial margin of the crown. The point where the two grooves join forms a depression in the occlusal surface, termed the central fossa. The mesial extremity of the mesio-distal groove is bifid. The bifurcation occurs about midway between the central fossa and the mesial margin. The lingual division runs straight to the middle of the mesial margin, which it grooves, the buccal division runs towards the mesio-buccal angle of the surface, about half-way toward which it terminates in a shallow depression which dimples the lingual slope of the mesio-buccal cusp. The lingual cusp occupies the whole of the occlusal surface upon the lingual side of the mesio-distal groove. It forms a crescentic elevation, the horns of the crescent being limited by the extremities of the mesio-distal groove, and separated by them from similar ridges extending from the mesio-buccal and disto-buccal cusps, which form, with the horns of the crescent, the mesial and distal margins of the occlusal surface. These are by some writers termed the mesial and distal marginal ridges. By some writers, too, the elevated margin formed on the buccal side of the occlusal surface by the disto-buccal and mesio-buccal cusps is termed the buccal marginal ridge.

The *buccal* surface (*Fig.* 9) is quadrilateral. Its occlusal margin is the buccal margin of the occlusal surface viewed laterally. The plane of the buccal surface is inclined towards the grinding surface, an inclination that appears more marked, on account of a well defined ridge that extends along the gingival margin. This ridge—the buccal ridge—the upper margin of which forms the cervical margin of the surface, extends from the mesial to the distal margin, being much more prominent at its mesial than at its distal extremity. The mesial margin is longer than the distal, and both are slightly convex. At the mesial margin, the buccal ridge is continued downwards towards the mesio-buccal cusp, so that the mesial extremity of the whole buccal surface is much more prominent than the distal. The buccal groove of the grinding surface is continued on to the buccal surface as a shallow depression, which forms the distal boundary of the mesial prominence.

Fig. 9.

The *lingual* surface is uniformly convex. Its margin also is convex. Its cervical margin marks the junction of the lingual root with the crown. Its mesial and distal margins merge imperceptibly into the mesial and distal surfaces of the crown, and its occlusal margin is the lingual margin of the grinding surface, viewed laterally.

The *mesial* surface is flattened. Its plane is much inclined towards the lingual surface,—this inclination allowing for the abrupt curve that takes place in the arch formed by the upper temporary teeth. The occlusal, buccal, and lingual margins of this surface correspond to the mesial of the grinding, buccal, and lingual surfaces respectively. The cervical margin is slightly concave.

The *distal* surface is convex. Its cervical margin is straight and well marked. Its buccal and lingual margins merge imperceptibly into the distal margins of the adjacent surfaces of the crown. Its occlusal margin is notched by the distal extremity of the mesio-distal groove.

The **root** of this tooth has three fangs, the mesio-buccal, the disto-buccal, and the lingual. From the neck of the tooth, which is formed by the coalescence of these fangs, they diverge in the directions indicated by their respective names. All taper gradually to their apical extremities. The lingual root is the longest. It is convex upon its lingual side, but somewhat flattened upon the opposite. The mesial and distal roots separate from the lingual rather sooner than from each other. Although the three roots diverge very markedly on the whole, yet just towards their apical extremities, there is a slight tendency to convergence.

THE UPPER SECOND MOLAR has a root with three fangs.

Its **crown** is roughly cubical, and is considerably larger than that of the first molar. It presents for examination five surfaces.

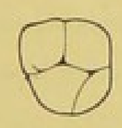


Fig. 10.

The *occlusal* surface (*Fig.* 10) is rhomboidal, with rounded angles. It is marked by three grooves which divide four cusps. The grooves are the mesio-buccal, the disto-lingual, and the connecting. The four margins of this surface are slightly convex. The mesial margin forms an acute angle with the buccal, and an obtuse angle with the lingual, and, as the surface is rhomboidal, the opposite angles correspond.

The mesio-buccal groove runs with a deep curve from about the centre of the mesial margin to the centre of the buccal margin. This groove is by some writers described as two—the mesial and the buccal.

The disto-lingual groove runs from the centre of the distal margin to the centre of the lingual margin. It does not curve deeply inwards towards the centre of the surface as does the mesio-buccal, but is nearly straight. The connecting groove joins these two grooves, running from the centre of the mesio-buccal to meet the disto-lingual near its distal extremity. The deep depressions of the surface which mark the junction of the connecting groove with the mesio-buccal and the disto-lingual, are the central fossa and the distal fossa respectively.

The mesio-buccal groove divides the mesio-buccal cusp from the mesio-lingual and disto-buccal cusps.

The disto-lingual groove divides the disto-lingual cusp from the disto-buccal and the mesio-lingual.

The connecting groove divides the mesio-lingual from the disto-buccal cusp.

The mesio-buccal and disto-buccal cusps are the most pointed; their extremities, and the ridges that descend from them, form the buccal margin of the surface. The mesio-lingual cusp usually occupies the largest share of the surface, but is more rounded than the buccal cusps, and its highest point is more centrally situated.

Although the connecting groove is said, for descriptive purposes, to divide this cusp from the disto-buccal, yet, on account of the greater comparative depth of the central and distal fossæ, these two cusps appear to be joined by a well-marked ridge—the oblique ridge. The disto-lingual cusp is usually the smallest.

The mesial extremity of the mesio-buccal groove is generally bifurcated, and the ridge enclosed by the bifurcation, which is really part of the mesio-buccal cusp, appears almost as an independent ridge.

The *buccal* surface of the crown (*Fig.* 11) is quadrilateral in outline, its mesial half being convex, its distal rather flattened. It is divided almost equally by the buccal groove, which is the continuation of the mesio-buccal groove of the crown. This groove, which is very slightly nearer the distal than the mesial margin, notches the occlusal margin, and terminates near the centre of the surface in a small pit, the buccal pit. Rarely, it traverses the whole surface. The distal margin is convex, the mesial almost straight, except for the rounding of its occlusal extremity. Both converge to join the cervical margin, which is straight. Dental writers usually describe a ridge (the bucco-gingival or cervical ridge), which crosses the buccal surface just beneath and parallel to the cervical margin. This is not found unless the buccal groove and pit are well marked.

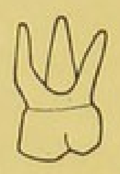


Fig. 11.

The *lingual* surface is, except for its greater convexity, in general appearance and outline somewhat similar to the buccal. Its mesial margin is more convex than that of the buccal surface.

Its occlusal margin is notched by a groove, the continuation of the disto-lingual, which upon this surface becomes the lingual groove. This groove terminates near the centre of the surface, and divides it into two convex ridges. Occasionally this groove is absent, when the whole surface is uniformly convex. The cervical or gingival margin is horizontal.

The *mesial* surface is flat, and quadrilateral in outline. Its buccal and lingual margins are convex. Its occlusal and cervical margins are concave. The plane of this surface is inclined towards the lingual side, but not so markedly as in the case of the first molar.

The *distal* surface is convex, and quadrilateral. Its buccal and lingual margins are convex, the lingual more so than the buccal. The occlusal margin is concave, the cervical nearly straight. Very often there is a considerable flattening, amounting sometimes to concavity, of the buccal half of this surface towards the cervical margin; and, occasionally, the surface is marked centrally by a slight groove, the continuation of the disto-lingual groove of the grinding surface. When present, this runs from the centre of the occlusal margin to the centre of the cervical margin.

The **root** of this tooth has three fangs, which resemble those of the first molar. As a rule, the mesio-buccal root is relatively longer, often being as long or longer than the lingual.

THE LOWER CENTRAL INCISOR is much smaller than the upper. The **crown** in general outline somewhat resembles that of the upper lateral incisor.

Fig. 12.

The *labial* surface (*Fig.* 12) is smooth and convex. Its occlusal margin (cutting edge) is transverse to the long axis of the tooth, and the angles it makes with the mesial and distal margins of the labial surface are not rounded but distinct. The mesial and distal margins of the labial surface are almost straight, and converge towards each other to form the cervical margin. The convergence of the distal margin is slightly more marked than that of the mesial; in other words, while the mesial margin makes almost a right angle with the cutting edge, the angle formed by the distal margin is somewhat less. The cervical margin is very convex, and owing to the convergence of the mesial and distal margins, the labial surface is about one-third narrower near the cervical margin than at the cutting edge. The labial surface slopes away slightly in the direction of the distal angle.

The *lingual* surface is concave, except towards the cervical margin where it becomes convex. The mesial and distal margins of this surface are slightly convex, and converge to form the cervical margin, where the surface is narrowed almost to a point. This narrowing of the surface accentuates the prominence of the enamel just above the cervical margin.

Fig. 13.

The *mesial* and *distal* surfaces (*Fig.* 13) are flattened, and as their planes diverge from their gingival margins towards the cutting edge of the teeth, the surfaces appear to be concave. The cervical margins of both these surfaces are markedly concave, and, as the enamel ends abruptly, the neck of the tooth appears to be very constricted—this, by the way, being a marked feature of all the teeth of the temporary set.

The **root** of this tooth tapers gradually from the neck of the tooth to the apex of the root. It is much flattened, and occasionally grooved vertically in its mesial and distal surfaces, and, as a result, the labio-lingual diameter is much greater than the mesio-distal. The tapering of the root is chiefly at the expense of its labial aspect.

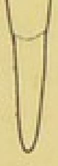


Fig. 14.

THE LOWER LATERAL INCISOR (*Fig.* 14) is slightly larger than the central incisor, and otherwise differs from it in the following respects. The distal angle of its **crown** is rounded off; and the concavity of its lingual surface is not encroached upon to the same extent by the cervical ridge, as in the case of the lower central incisor.

The **root** of this tooth has a fang which is usually longer than that of the lower central incisor.

THE LOWER CANINE (*Fig.* 15) resembles the upper canine of the opposite side in general shape.

Its **crown** is narrower in its mesio-distal diameter, and the convexity of its labial surface is, as a rule, a little more pronounced.

The **root** of this tooth has a fang which is longer than those of the lower incisors.

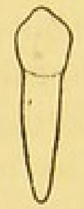


Fig. 15.

THE LOWER FIRST MOLAR has a root with two fangs.

The mesio-distal diameter of its **crown** is greater than its labio-lingual; and the labio-lingual diameter is much greater just above the gingival line than at the occlusal surface.

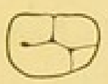


Fig. 16.

It presents for examination five surfaces. The *occlusal* surface (*Fig.* 16)* is roughly ovoid, the largest diameter being the mesio-distal. It has four cusps—a mesio-buccal, a disto-buccal, a mesio-lingual, and a disto-lingual. These are separated by two grooves, the mesio-distal and the bucco-lingual. The mesio-distal groove commences as a well marked pit near the mesial margin of the occlusal surface. It passes in an irregular course backwards to the distal margin of the surface, where it terminates imperceptibly. At first, it is directed slightly towards the buccal side until it meets the bucco-lingual groove, where the two grooves form one, which takes a course directed somewhat towards the lingual side. At about the junction of the middle and distal third of the occlusal surface, the two grooves divagate, the bucco-lingual passing direct to the

* The outline of this diagram, at first sight, appears inaccurate; the reason being that, in looking down upon the surface of the actual tooth one sees a good deal of the buccal surface which does not appear in the diagram.

lingual margin, the mesio-distal to the distal margin. At the point of junction and divagation of these two grooves there is a well marked pitting of the enamel. The buccal extremity of the bucco-lingual groove divides the mesio-buccal from the disto-buccal cusp, and passes on to the buccal surface of the crown.

The mesio-buccal cusp is generally well marked, and is continuous anteriorly with the mesio-lingual cusp, by a mesial ridge, which forms the mesial border of the anterior surface. The mesio-lingual cusp is the most pointed of the four cusps, and is separated from the mesio-buccal by the mesial extremity of the mesio-distal groove, except where it helps to form the mesial marginal ridge. The pitting at the mesial extremity of the mesio-distal groove, and at the point where it meets the bucco-lingual groove, leaves the appearance of a slight ridge of enamel connecting the mesio-lingual and mesio-buccal cusps. This is the transverse ridge.

The disto-buccal cusp is separated from the mesio-buccal by the bucco-lingual groove, and from the mesio-lingual by the groove formed by the junction of the mesio-distal and the bucco-lingual grooves, and from the disto-lingual by the mesio-distal groove.

The disto-lingual cusp is small and rounded. It is separated from the mesio-lingual by the bucco-lingual groove, and from the disto-buccal by the distal extremity of the mesio-distal groove.

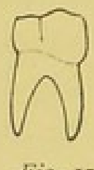


Fig. 17.

The *buccal* surface (*Fig.* 17) is quadrilateral. Its cervical margin is raised in a well marked ridge—the buccal ridge—from which the surface slopes towards the occlusal margin. The mesial and distal margins are rounded, the mesial being much longer than the distal. The occlusal margin is formed by the mesio-buccal and disto-buccal cusps viewed laterally, and is deeply notched by the bucco-lingual groove. The groove traverses the buccal surface, and, as a rule, ends abruptly in a pit—the buccal pit—just above the ridge forming the cervical margin.

The *lingual* surface is convex, except where it is encroached upon by the lingual extremity of the bucco-lingual groove.

The *mesial* surface is flattened. Its plane is inclined in the mesio-lingual direction, and, as a result, the angle formed by it with the buccal surface is acute, while that formed with the lingual surface is obtuse.

The *distal* surface is rounded. The planes of both the mesial and distal surfaces slope towards the cervical margin.

The **root** of this tooth has two fangs, a mesial and a distal. These diverge widely. Both are flattened and grooved mesio-distally. They taper to their extremities, chiefly at the expense of their buccal and lingual surfaces, their mesial and distal surfaces being about as broad at their apices as at the cervical margins.

THE LOWER SECOND MOLAR has a root with two fangs.

The **crown** of this tooth is roughly cubical. It presents for examination five surfaces.

The *occlusal* surface (*Fig.* 18) is trapezoid in outline. Its four margins are the mesial, the distal, the buccal, and the lingual respectively. Of these the buccal is the longest. The occlusal surface is marked by three grooves, a mesio-distal, a bucco-lingual, and a disto-buccal. The mesio-distal groove is generally bifid at its commencement near the mesial margin. The junction of the forked extremity is marked by a pit, from which the groove continues directly backwards towards the distal margin, until it is

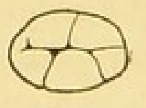


Fig. 18.

intersected by the bucco-lingual groove. With this it joins, and runs for a short distance towards the lingual margin, when it abruptly resumes its distal direction, in which it continues as far as the distal margin, over which it passes. The disto-buccal groove arises from the mesio-distal about half-way between its junction with the bucco-lingual and the distal margin of the surface. It runs with a slight distal inclination towards the buccal margin, over which it passes. The bucco-lingual groove appears upon the occlusal surface, at the junction of the anterior and middle thirds of the buccal margin, which it deeply notches. Taking a direction slightly inclined to the distal, it runs to the centre of the lingual margin, over which it passes on to the lingual surface. In its course it is joined by the mesio-distal groove, as already mentioned. The occlusal surface of the second temporary molar has five cusps—a mesio-buccal, a buccal, a disto-buccal, a mesio-lingual, and a disto-lingual. Of these, the mesio-buccal is often the largest. It is divided from the disto-buccal by the bucco-lingual groove, and from the mesio-lingual by the mesio-distal groove, except at the mesial margin, where it joins with the mesio-lingual cusp to form the marginal ridge which forms the mesial border of the surface. The buccal cusp is divided from the distal by the disto-buccal groove, from the disto-lingual cusp by the mesio-distal groove, and from the mesio-lingual cusp by the junction of the mesio-distal and bucco-lingual grooves. The mesio- and disto-lingual cusps are bounded on the buccal side by the mesio-distal groove, and are separated by the bucco-lingual groove. They are usually of equal size. The disto-buccal cusp is the smallest of the five, and is separated from the disto-lingual cusp by the mesio-distal groove, and from the buccal cusp by the disto-buccal groove. In equally well-formed teeth these cusps may vary considerably in their relative size; and the shape and direction of the margins of the occlusal surface vary with the cusps. In a typical example, the mesial, the distal, and the lingual margins are nearly straight. The buccal margin is always convex, and deeply notched by the bucco-lingual and disto-lingual grooves The buccal margin being longer than the lingual, it forms an acute angle with the mesial and the distal margins, while the lingual forms an obtuse. The deep depresssion which is centrally situated between the cusps, is termed the central fossa.

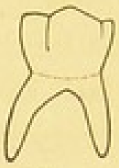


Fig. 19.

The *buccal* surface (*Fig.* 19) is convex, and marked by bucco-lingual and disto-buccal grooves, which are continued on it from the occlusal surface. The bucco-lingual groove marks this surface vertically, a little to the mesial side of the centre. It terminates abruptly in a small pit, slightly nearer the cervical than occlusal margin. The disto-buccal groove also runs vertically down this surface, but near to the distal margin. It can sometimes be traced to the junction of the cervical and distal margins, but generally terminates imperceptibly before reaching that point. The buccal surface has four margins. The occlusal is the longest, and is notched by the bucco-lingual and the disto-lingual grooves. This margin forms acute angles with the mesial and distal margins, which converge towards the cervical margin, which is slightly concave towards the occlusal surface. The abrupt termination of the bucco-lingual groove gives the appearance of a ridge above the cervical margin of this surface. This is the buccal ridge.

The *lingual* surface is also convex. Its occlusal margin is notched centrally by the bucco-lingual groove, which runs vertically, and terminates imperceptibly about half-way between the occlusal and the cervical margins. The cervical margin is straight, and the mesial and the distal slightly convex.

The *mesial* surface is flat over its centre and towards the cervical margin, and rounded towards the lingual and buccal margins. Its occlusal margin is V-shaped, being formed by the adjacent slopes of the mesio-lingual and mesio-buccal cusps. The lingual and the buccal margins are convex, and the cervical concave.

The *distal* surface is convex. The occlusal margin is notched by the mesio-lingual groove, which can sometimes be traced on to this surface. The buccal and the lingual margins are convex, and the cervical margin is straight. The planes of the mesial and the distal surfaces converge towards the lingual side, and, consequently, the lingual surface is much less in extent than the buccal.

The **root** of the lower second temporary molar has two fangs, which closely resemble those of the first lower temporary molar. Like them, they diverge widely, but there is often, near their extremities, a tendency to convergence, so that the mesial surface of the mesial fang, and the distal surface of the distal fang, are convex from above downwards, and the distal surface of the mesial fang, and the mesial surface of the distal fang, are concave from above downwards.

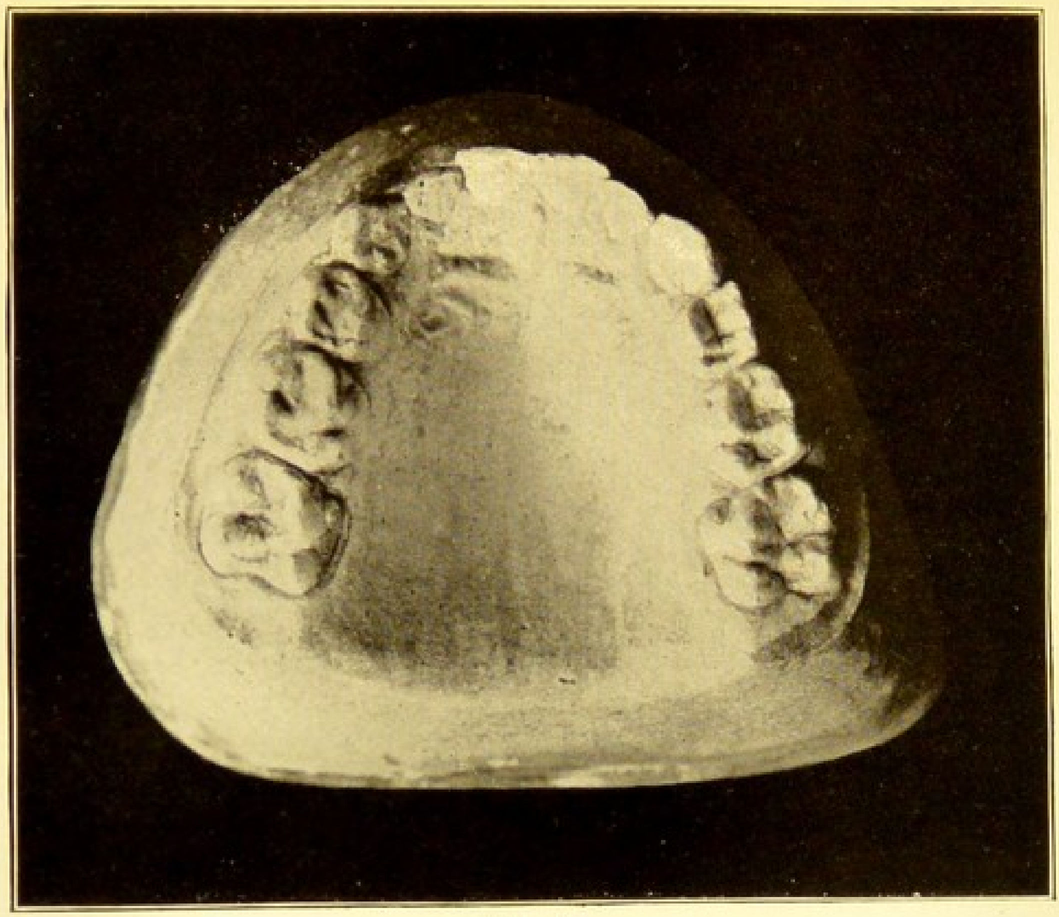


Fig A.

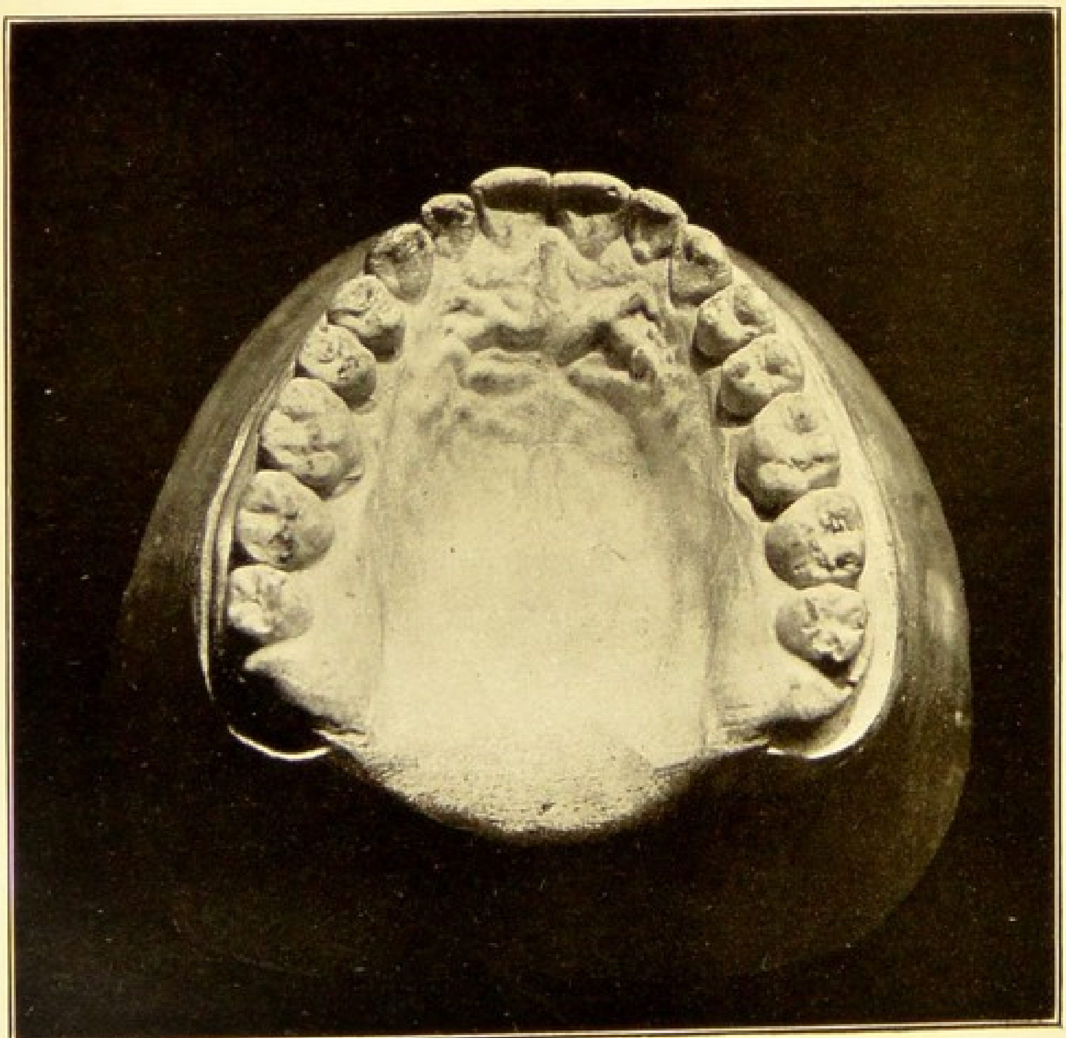


Fig. B.

CHAPTER III.

THE PERMANENT TEETH.

THE PERMANENT TEETH that first make their appearance in the mouth are called the **first molars.** They are sometimes termed the *six year old molars,* on account of the age at which they make their appearance. They are four in number. Their relative size and shape, and the position they occupy in the mouth with regard to the temporary teeth, may be seen by reference to the accompanying illustration, (*Plate IV, Fig. A*), which is a photograph of a cast of the upper teeth of a child six years of age. The six year old molars erupt so unobtrusively that they are often mistaken for members of the temporary set, a mistake to which their untimely loss may not infrequently be attributed, for they are very liable to decay; and, in this country, parents often allow them to be neglected, thinking that they will be replaced.

The permanent teeth that next erupt are the **lower central incisors.** These replace the temporary teeth of the same name, which are removed to make room for them. This removal is effected by a process termed **resorbtion,** by which the roots of the temporary teeth are dissolved away. Similarly the **upper central,** the **lower lateral,** and the **upper lateral** temporary incisors are next replaced by permanent successors of the same name. Then the eight temporary molars are replaced by permanent teeth which are termed **premolars,** or, from the shape of their crowns, *bicuspids.* The premolar teeth that replace the first molars are termed the first premolars, and those that replace the second molars the second premolars. The temporary **canines** are replaced by permanent successors of the same name; then the dental arches are enlarged by the addition to each of their extremities of another molar, the **second** (*twelve year old*) **molar**; and finally the eruption of the **third molars** (*wisdom teeth*), which are four in number, and form the extremities of the dental arches, completes the permanent set.

The following table gives approximately the **dates of eruption** of the permanent teeth. As with the temporary teeth, these dates are liable to considerable variation, particularly in the case of the third molar teeth.*

Years.	Teeth.
6.	The first permanent molars
7—8.	The central incisors
9.	The lateral incisors
9—11.	The premolars
11.	The canines
12.	The second molars
17—21.	The third molars (wisdom teeth).

Plate IV, *Fig. B* is a photograph of a cast of the upper row of the permanent teeth. Its comparison with *Plate III*, *Fig. A*, will show the relative sizes of the temporary and permanent teeth, and the shape of the arches that they form.

The permanent dentition is expressed by the following **formula**:

$$I\tfrac{2}{2}\ C\tfrac{1}{1}\ P\tfrac{2}{2}\ M\tfrac{3}{3} = 32.$$

The same remark applies to this formula as to that of the temporary dentition.

* At the time of writing the author has a patient sixty-four years of age, whose left upper third molar has just commenced to erupt

The permanent **incisor** and **canine** teeth of both the upper and lower arches so closely resemble those of the temporary set in general outline that no detailed description of the surfaces of their crowns is necessary.

The main points of difference are the following :—The **crowns** of the permanent teeth are much larger than those of the corresponding milk teeth. The enamel is different in colour; that of the temporary teeth being a uniform milk-white, while that of the permanent teeth varies from milk-white to yellow or bluish-grey. The colour of the individual teeth of the permanent set, moreover, is not, as a rule, uniform. The colour is lighter at the cutting edge than elsewhere, gradually deepening in shade towards the cervical margin. The colour of the canine teeth is as a rule slightly more pronounced, and more uniform than that of the incisor teeth.

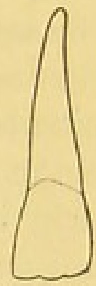


Fig. 20.

In the young subject the cutting edges of the permanent incisor teeth are serrated (*Fig.* 20), two well marked notches separating a central from a mesial and a distal tubercle. Extending vertically from these notches across the labial surface towards the cervical margin are two grooves—the developmental grooves. Usually these are well marked, but in some cases they are indistinguishable. Corresponding grooves can usually be traced upon the lingual surface, but they are not as a rule so well marked as upon the labial. The serrations of the cutting edges are soon worn away by attrition. Developmental grooves are similarly found upon the labial and lingual surfaces of the permanent canines, but they do not notch the cutting edge.

The distal angle of the crown of the lower permanent **lateral** incisor, is more acute than the mesial angle, thus differing from the lower temporary lateral incisor. The mesial surface of the upper permanent lateral incisor is invariably concave towards its cervical margin ; and the lingual tubercle is frequently accentuated so as to appear almost as a small cusp, often with a pit between it and the concavity of the surface.* (*Fig.* 21).

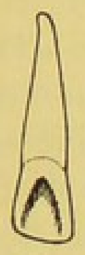


Fig. 21.

The lower **canine** (*Fig.* 22) of the permanent set differs from the upper canine rather more than is the case with the temporary teeth. The mesio-distal diameter of the crown of the lower canine is considerably less than that of the upper, measured from angle to angle. The mesial and distal margins of the labial surface of the lower canine do not diverge towards the cutting edge so markedly as those of the upper, and consequently the buccal surface appears on inspection to be larger in comparison than is found to be the case by actual measurement. The cutting edge of the lower canine is much shorter than that of the upper, and the mesial margin of the labial surface is nearly in a line with the long axis of the tooth, so that the crown seems to overhang to the distal—an appearance that is accentuated by the cusp of the lower canine being nearer the mesial angle of the crown, than is the case in the upper tooth.

Fig. 22.

The **roots** of the permanent incisor and canine teeth are relatively shorter than those of the corresponding temporary teeth, and they are also relatively greater in circumference.

The **premolar** teeth of the permanent set do not at all resemble the teeth of the temporary set that

* This lingual tubercle is known to comparative anatomists as the **Cingulum.**

they replace. Detailed description of these is therefore necessary.

THE UPPER FIRST PREMOLAR (*First Bicuspid*) has a root with two fangs.

The **crown** of this tooth presents for examination five surfaces, occlusal, buccal, lingual, mesial, and distal.

Fig. 23.

The *occlusal* surface (*Fig.* 23) is trapezoid in outline. It presents for examination two cusps and one groove. The cusps are the buccal and the lingual, the groove is the mesio-distal. The mesio-distal groove is bifid at both its extremities. The undivided portion separates the two cusps, and with the lingual divisions of its extremities, passes in a nearly straight line across the surface from the mesial to the distal margin, rather more to the lingual than the buccal side of the tooth. The buccal branches of its extremities arise at the junction of the middle with the mesial and distal thirds of this line, and pass towards the mesio-buccal and disto-buccal angles of the surface respectively, near which they fade imperceptibly. The points of bifurcation of the mesio-distal groove are marked by deep pits, the mesial and the distal pits respectively.

Of the cusps, the buccal is the larger and the more prominent. The point of the cusp is rather nearer the distal than the mesial margin, and about half way between the most prominent part of the buccal surface and the mesio-distal groove. From it four ridges descend, one to the buccal surface, one to the mesial and the distal respectively, and one, the lingual ridge, towards the mesio-distal groove. The mesial ridge forms the mesio-buccal angle of the crown, and is prolonged round the mesial margin, which it forms as far as the lingual branch of the mesial extremity of the mesio-distal groove. This prolongation of the mesial ridge is separated from the lingual ridge of the buccal cusp by the buccal branch of the mesial extremity of the mesio-distal groove. In exactly the same manner the distal ridge is prolonged round the distal margin, and is separated from the lingual ridge of the buccal cusp by the buccal branch of the distal extremity of the mesio-distal groove. The lingual cusp is rounded, and not nearly so prominent as the buccal. It is bounded on the buccal side by the mesio-distal groove, and the lingual branches of its extremities. It forms the whole of the lingual margin of the occlusal surface, and the mesial and distal margins as far as the lingual branches of the extremities of the mesio-distal groove. The buccal margin of the occlusal surface is formed by the point of the buccal cusp and the mesial and the distal ridges that descend from it.

The lingual margin of the occlusal surface is convex, and rounds off into the mesial and distal margins, which are nearly straight, and converge towards the lingual side.

The *buccal* surface of the crown so closely resembles the labial surface of the canine that a separate description is unnecessary, the chief difference being that the point of the cusp is nearer the distal extremity of the occlusal margin than the mesial, the reverse being the case in the canine tooth.

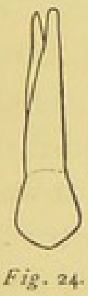


Fig. 24.

The *lingual* surface (*Fig.* 24) is convex. Its cervical margin is transverse to the long axis of the tooth. Its mesial and distal margins round off imperceptibly into the mesial and distal surfaces. In outline they are nearly straight, and diverge towards the occlusal margin, the divergence of the mesial margin being the more marked. The occlusal margin is somewhat V-shaped, the point of the V being the summit of the lingual cusp, and is as a rule nearer the mesial than the distal margin.

The *mesial* surface (*Fig.* 25) has four margins. The buccal and the lingual are convex in outline, with a general convergence towards the occlusal margin. The cervical margin forms a sharp angle with the buccal, whence its buccal half sweeps in a downward curve towards the lingual margin. It then takes a straight course to the lingual side of the tooth. Its buccal half is therefore concave, its lingual straight. The occlusal margin is V-shaped, the point of the V being directed towards the cervical margin. The mesial surface usually presents a slight concavity beneath the middle third of the cervical margin. It is markedly convex near the lingual margin, and where it rounds off towards the lingual cusp. Its buccal margin is prominent.

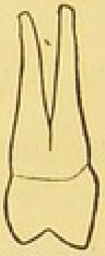


Fig. 25.

The *distal* surface resembles the mesial in general outline, but is more convex. Both the mesial and distal surfaces converge to the lingual side, and as a result, the lingual surface of the crown is much smaller than the buccal.

The upper first premolar has a **root** with two fangs, a buccal and a lingual (*Fig.* 25). These are as a rule separate only for about half their length, the cervical half of the root being formed by their coalescence. This half is much flattened mesio-distally, and marked on the mesial and distal aspects by a groove, which indicates the line of junction of the two fangs. The fangs when they separate are cylindrical and taper to fine points. Occasionally the two fangs coalesce through the whole of their length; and, more seldom, the root has three fangs.

THE UPPER SECOND PREMOLAR (*Second Bicuspid*).

The **crown** of this tooth closely resembles that of the first bicuspid, but it is slightly smaller. A detailed description of its various surfaces is therefore unnecessary. The characteristic difference is the shortening of the central undivided portion of the mesio-distal groove; this being often merely an elongated pit from which the bifurcated extremities diverge (*Fig.* 26). The cusps are rather less prominent, and the mesial and distal surfaces are more convex than those of the first premolar. The buccal cusp is smaller than that of the first premolar, and the lingual comparatively larger.

Fig. 26.

The **root** of this tooth has a single fang, which is flattened mesio-distally. On its mesial aspect it is marked by a vertical groove for the greater part of its length. It tapers at the expense chiefly of its buccal and lingual surfaces, and terminates in a flat broad apex, which is occasionally bifid.

THE UPPER FIRST MOLAR has a root with three fangs.

Its **crown** in general outline so closely resembles the upper second temporary molar that its surfaces require no detailed description (*Fig.* 10). There is, however, this marked difference, that in many instances the permanent molar has a **fifth cusp**, which, when well developed, forms the mesio-lingual angle of the occlusal surface, and is separated from the mesio-lingual cusp by a groove—the mesio-lingual groove (*Fig.* 27). This groove, when the fifth cusp is large and well marked, extends from the lingual extremity of the disto-lingual groove to the mesial extremity of the mesio-buccal groove. Quite often it is merely a wrinkle that breaks the lingual slope of the mesio-lingual cusp. The fifth cusp, even when fully developed, is always the

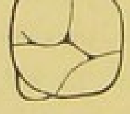


Fig. 27.

smallest of the five. The enamel of the crown of the permanent first molar terminates less abruptly than that of the crown of the upper second temporary molar, and its neck as a result appears less constricted.

The fangs of the **root** of the permanent tooth are much less divergent than those of its temporary prototype, and the tooth as a whole is, of course, much larger. Another point of difference is that the part of the root formed by the coalescence of the fangs forms a greater proportion of the bulk of the root in the permanent than in the temporary tooth; in other words, the fangs of the temporary tooth appear to spring more directly from the crown. The mesio-buccal root of the permanent tooth is generally recurved, its apex sometimes touching the apex of the disto-buccal fang (*Fig.* 28).

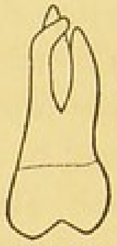


Fig. 28.

The Upper Second Molar in general outline so closely resembles the first molar, that special description of the various surfaces of its **crown** is unnecessary. It never has the fifth cusp we sometimes find in the occlusal surface of the first permanent molar, and its crown is smaller than the crown of that tooth. Another striking difference between these two teeth is the marked diminution of the disto-lingual cusp in the case of the second molar. The buccal surface often slopes considerably towards its disto-cervical angle, which results in the disto-buccal angle of the neck being truncated.

The **root** of this tooth has three fangs, which are as a rule less divergent than those of the first molar, in fact, two or more fangs often coalesce. Towards their apical extremities they generally have a marked distal curve.

The Upper Third Molar (*Wisdom Tooth*).

The **crown** is very irregular in its form, even in cases where the other teeth are typical. The best specimens resemble the second molar in general outline, except that the disto-lingual cusp is even smaller than is the case in that tooth, and the occlusal surface tends to a more circular outline. Often the tooth has only three cusps, a mesio- and disto-buccal, and a lingual; and occasionally the crown consists of nothing more than a mere nodule of enamel. Not infrequently these teeth are suppressed altogether.

The **root** of this tooth is as variable as the crown. It sometimes has three separate fangs somewhat resembling, but smaller than, those of the second molar. More often the fangs are united to form a single root, and occasionally the root has four or five fangs.

THE LOWER FIRST PREMOLAR has a root with a single fang.

The **crown** is smaller than those of the upper premolars, and differs from them markedly in shape.

Fig. 29.

The outline of its *occlusal* surface is flattened on the buccal, and rounded on the lingual side (*Fig.* 29). This surface presents for examination two cusps and two pits. The buccal cusp is extremely prominent, and as much of the buccal surface is visible when looking down upon the occlusal surface, it appears to occupy a more central position than does the buccal cusp of the upper premolars. This is due to the extreme convexity of the buccal surface. From the buccal cusp descend three ridges, the mesial, distal, and the buccal half of the transverse. The mesial and distal ridges with the cusp form the buccal margin of the occlusal surface, and then curve round to form the buccal half of the mesial and distal margins.

The lingual cusp is much smaller and less prominent than the buccal. From it descend three ridges; a mesial and distal, to join the mesial and distal from the buccal cusp, and with them to complete the mesial and distal margins of the occlusal surface; the third ridge being the lingual half of the transverse ridge, which, with the half from the buccal cusp, completes the transverse ridge, which stretches direct from the buccal to the lingual cusp. This transverse ridge separates two well marked pits, the mesial and distal respectively.

The *buccal* surface, except that it is much more convex vertically, so closely resembles that of the upper first premolar that a special description is unnecessary. The point of the cusp is as a rule situated midway between the extremities of the occlusal margin; never distally as in the case of the upper first premolar.

The *lingual* surface is convex in all directions, slightly so vertically, markedly so from mesial to distal, where it rounds off into the mesial and distal surfaces. Owing to the small size of the lingual cusp, and convergence of the planes of the mesial and distal surfaces, the extent of the lingual surface is very small.

The *mesial* and *distal* surfaces are similar. (*Fig.* 30). The planes of both slope towards the cervical and the lingual margins. The buccal and lingual margins of both surfaces are convex, the lingual slightly, the buccal strongly. The occlusal and cervical margins are concave. The surfaces are rounded and prominent near their occlusal margins, becoming slightly concave in a vertical direction near the cervical margins. Both surfaces are convex in the bucco-lingual direction.

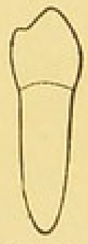


Fig. 30.

The enamel of the crown of this tooth terminates abruptly, leaving a well-marked lingual margin, and an apparently constricted neck.

The **root** is usually straight, but it sometimes has a very slight distal curve. On transverse section near the neck, it is oval, the long diameter of the oval being the bucco-lingual, and the longest transverse diameter of the oval being nearer the buccal than the lingual surface. Towards the apex of the root a transverse section has a more circular outline. The mesial and distal surfaces of the root are flattened for the cervical two-thirds of their length, or even show a slight vertical central groove. Their lingual margins are straight, their buccal convex. The buccal and lingual surfaces of the root are much narrower than mesial and distal, and taper regularly to the apex.

THE LOWER SECOND PREMOLAR has a root with a single fang.

The **crown** somewhat resembles the first in general outline, but differs greatly in one or two respects. Thus the lingual cusp is much more fully developed, reaching nearly to the horizontal level of the buccal cusp.

The *occlusal* surface varies considerably. Occasionally it resembles the occlusal surface of the upper premolars, the chief differences being that the mesio-distal diameter of the lingual cusp is longer in the lower tooth, and the mesio-distal groove is crescentic, with its concavity towards the buccal side.

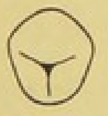


Fig. 31.

Not infrequently the tooth is tricuspid (*Fig.* 31), the lingual cusp being divided by a groove running from the centre of the mesio-distal groove to the lingual margin.

As a rule the mesial and distal marginal ridges are broad and well developed, giving a squarish outline to the occlusal surface.

The *buccal* surface closely resembles that of the first lower premolar.

The *mesial* and *distal* surfaces are convex. Their planes do not converge to the lingual, and as a consequence the lingual surface is almost as extensive as the buccal.

The *lingual* surface is convex in every direction. Its occlusal margin is V-shaped, the point of the lingual cusp being the apex of the V. Its cervical margin is straight, and transverse to the long axis of the tooth.

The **root** of this tooth is rather longer than that of the lower first premolar, which it resembles in general outline, except that the buccal margins of its mesial and distal surfaces are straighter.

THE LOWER FIRST MOLAR has a root with two fangs.

Its **crown** so closely resembles that of the lower second temporary molar in general outline that separate description is unnecessary.

The **root** of this tooth differs markedly from that of the lower second temporary molar (*Fig.* 32). Its fangs are not so divergent. The mesial fang, which is broad from buccal to lingual and narrow from mesial to distal, is generally grooved vertically on both its mesial and distal surfaces. The mesial surface of the mesial fang is convex from above downwards, while its distal surface is concave in the same direction. The fang, therefore, is curved throughout its length, the hollow of the curve being towards the distal. Sometimes this fang is bifurcated in the line of the vertical groove.

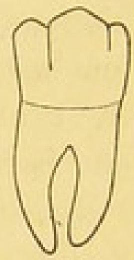


Fig. 32.

The distal fang is not so flattened as the mesial. As a rule it has a slight distal curve like the mesial, but sometimes it is almost straight, which brings the apices of the fangs close together. The root of this tooth differs from the root of its temporary prototype in the same manner that the root of the upper first permanent molar differs from the root of the upper second temporary molar, that is to say, the fangs appear to spring less directly from the base of the crown.

THE LOWER SECOND MOLAR has a root with two fangs.

In some cases the **crown** of this tooth exactly resembles that of the lower first molar. Generally it differs from it in so far as it lacks the disto-buccal cusp.

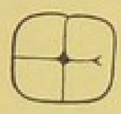


Fig. 33.

The *occlusal* surface (*Fig.* 33) is the most regular in outline and marking of all the molar teeth. It is oblong, with rounded angles. It presents for examination four cusps separated by two grooves, The cusps are the mesio and disto-buccal, and the mesio and disto-lingual. The grooves are the mesio-distal and bucco-lingual. The mesio-distal groove is bifid at its commencement, just within the central portion of the mesial margin of the occlusal surface. The point of junction of the forked end is marked by a minute pit, from which the groove runs directly in a distal direction across the occlusal surface to the distal margin, separating, as it does so, the mesio-buccal from the mesio-lingual cusp, and the disto-buccal from the disto lingual cusp. The bucco-lingual groove appears upon the occlusal surface at the middle of its buccal margin, which it notches, and then runs straight across to the centre of the lingual margin, which it also notches. At its point of intersection with the mesio-distal groove there is a well-marked pit, in the centre of a shallow depression—the central pit and the central fossa respectively.

The mesio-buccal and the mesio-lingual cusps are separated from each other by the mesial extremity of the mesio-distal groove, except just at the mesial margin, which is formed by ridges which extend from the cusps.

The disto-buccal and the disto-lingual cusps are usually rather larger than the mesio-buccal and the mesio-lingual, and are separated from each other by the distal extremity of the mesio-distal groove.

The *buccal* surface (*Fig.* 34) is convex. Its occlusal margin is deeply notched by the buccal extremity of the bucco-lingual groove which passes half-way across the buccal surface in a vertical direction, and sometimes terminates in a pit—the buccal pit. The cervical margin of the buccal surface is straight, the mesial and distal margins are slightly convex.

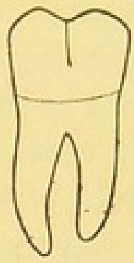


Fig. 34.

The *mesial* surface resembles that of the lower first molar.

The *distal* surface is smooth and convex. Its occlusal margin is notched by the distal extremity of the mesio-distal groove. The mesial and distal surfaces of the crown do not converge to the lingual, and there is therefore but little difference in the area of the buccal and lingual surfaces of the crown. The lingual surface resembles that of the first molar.

The **root** consists of two fangs, a mesial and distal, which are occasionally united, in which case a groove on the buccal and lingual aspects marks the line of coalescence. When the fangs are separate they closely resemble those of the lower first molar, except that they are rather less flattened.

THE LOWER THIRD MOLAR.

In its typical form the **crown** of this tooth resembles that of the lower second molar, but in many instances it differs from it considerably. Not infrequently it resembles the lower first molar, and when this is the case its crown is usually very large. When it does not assume one of the foregoing shapes, the crown of the lower third molar is multicuspid, a varying number of cusps being separated by grooves, which are irregularly disposed, and bear no resemblance to those of the other molar teeth. The outline of the occlusal surface of these multicuspid teeth is almost circular, and the mesial, buccal, distal, and lingual margins round off imperceptibly one into the other.

The **root** of this tooth varies considerably. In the typical form, and usually when the crown resembles that of the first molar, the root has two fangs, resembling those of the lower second molar, except that they generally have a very marked distal curve. When the crown assumes the more irregular form, particularly when it has the circular outline just described, the root is, as a rule, single, considerably recurved, and tapers rapidly to a pointed apex (*Fig.* 35).

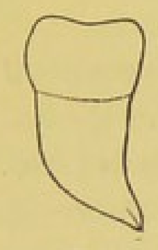


Fig. 35.

More rarely the root has three or more fangs.

It has already been stated that the temporary can be distinguised from the permanent teeth by their relatively smaller **size.** This applies more particularly to the incisor and canine teeth. The teeth of the permanent set vary considerably in size, and it is sometimes found that the crown of the first permanent molar is so very slightly larger than that of the second temporary molar of the same individual, as to make it impossible to decide without actual measurement, which is the larger tooth. The average length of the permanent lower canine tooth is one inch, and of this the crown forms two-fifths. The temporary lower canine is about seven-tenths of an inch in length, and of this the crown forms about the same proportion as in the case of the permanent tooth. The upper permanent canine is about a twentieth part of an inch longer than the lower, and is the longest of all the teeth.

The average breadth of the crown (mesio-distal diameter) of the permanent central incisor is seven-twentieths of an inch, while that of the permanent lateral incisor, and of the temporary central incisor, is a quarter of an inch. The average length of the crown of the permanent central incisor is two-fifths of an inch, that of the permanent lateral rather less. The length of the crown of the temporary lateral incisor is a quarter of an inch, and that of the temporary central incisor rather less. The average mesio-distal diameter of the crown of the upper second premolar scarcely exceeds a quarter of an inch, that of the lower first premolar is very slightly larger, while that of the upper first premolar and lower second premolar (the mesio-distal measurement of the crown of these being the same) is slightly larger still. The average mesio-distal diameter of the second and third permanent lower molars, and the upper first permanent molar, is rather less than nine-twentieths of an inch, and these teeth slightly exceed in this diameter the size of the other permanent molar teeth.

The average length of the roots of the permanent molar teeth is about half an inch, and of their crowns about three-tenths of an inch.

It has been stated that the teeth vary in size with the race. Of the teeth measured by the author, the largest were those of an English youth, while the smallest were those of an Englishman, who was very "underhung," this condition being due to excessive development of the mandible.

As a result of careful investigation, the author is of opinion that any classification of the teeth, as to size, of various races, is not to be regarded as distinctive, because individual variation is so marked as to render generalization extremely untrustworthy.

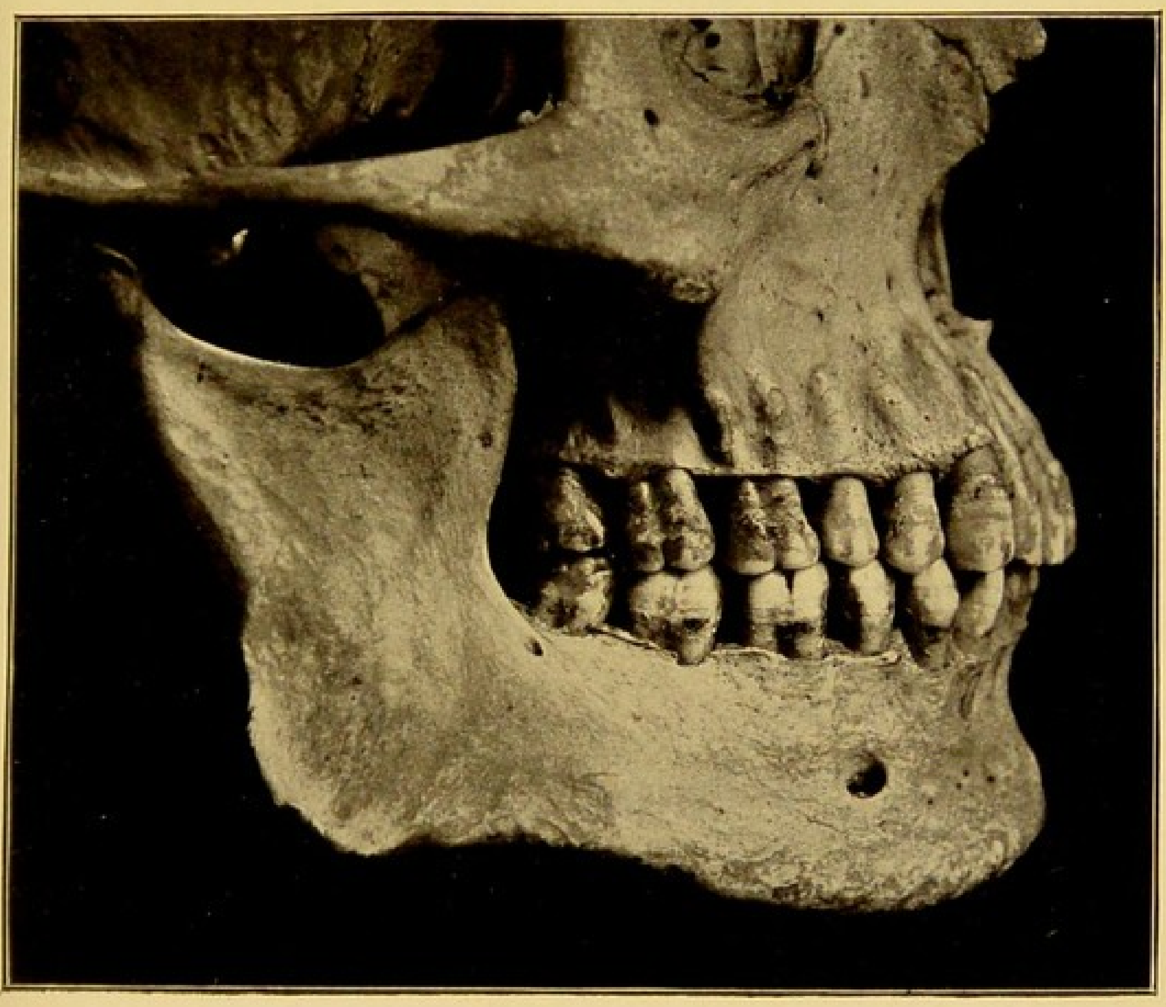
Chapter IV.

THE OCCLUSION OF THE TEETH.

THE teeth, as everybody has opportunities of observing, are arranged in two rows within the mouth. When the mouth is shut, the teeth of the lower row come into contact with those of the upper. As the manner of contact, or **occlusion**, as it is technically termed, is of some importance, the attention of the reader is directed to *Plate V.*, which shows the method of occlusion of the **permanent** set.

It will be seen that the lower teeth do not meet the upper ones cusp to cusp, but that the cusps of the upper and lower teeth inter-digitate. It must also be noted that the outer cusps of the upper molars and premolars slightly overlap those of the lower teeth, and that the cutting edges of the upper incisors overlap those of the lower incisors. In other words, the upper dental arch forms a rather larger curve than the lower. Another noteworthy point is that the grinding surfaces of the molars and premolars and the cutting edges of the incisors, are not in the same horizontal plane—that is to say, that if casts of the upper and lower permanent dental arches are placed upon the table with the cutting edges of the teeth downwards, the greater number of the teeth will not touch the table at all. The cast of the upper teeth will rest mainly upon the first molars, while that of the lower teeth will be supported by the third molar and the central incisor teeth. It is thus rendered apparent that the grinding surfaces of the lower molars and premolars form a slight

PLATE V.



curve, the *concavity* of which receives the grinding surfaces of the upper teeth. The cutting edges of the lower incisors and canines form a rather less marked curve, the *convexity* of which is directed upwards towards the upper incisors. It is obvious, therefore, that the upper molars and premolars must form a curve with their grinding surfaces, the convexity of which is downwards, and corresponds with the concavity formed by the grinding surfaces of the lower teeth with which they occlude. The cutting edges of the upper incisors and canines form a curve, the *convexity* of which is directed downwards—an arrangement that is rendered possible by their overlapping the lower incisor teeth.

The centre line of the inferior arch (viz., the point of contact of the lower central incisors with each other) is exactly beneath the corresponding point in the upper arch. About the upper one-third of the anterior surface of the lower central incisor teeth is concealed by the overlapping of the upper central incisor teeth. Since the lower incisor teeth are smaller than the upper, it follows that the upper central incisors overlap the lower central incisors and a part of the lower lateral incisors. The upper lateral incisors partly overlap the lower lateral incisors and canines. The lingual surface of the upper central incisors therefore comes into contact with the upper part of the labial surface of the lower central and lateral incisors of the same side, and the lingual surface of the upper lateral incisor comes into contact with the labial surface of the lower lateral incisor and canine of the same side. The labial surface of the lower canine also comes into contact with the lingual surface of the upper canine. In the teeth of adults all these points of contact are, as a rule, marked by facets—the result of attrition.

The distal part of the lingual surface of the upper canine comes into contact with the buccal surface of the first lower premolar.

The distal ridge of the buccal cusp of the inferior first premolar wedges between the mesial ridges of the buccal and lingual cusps of the upper first premolar.

The buccal cusp of the inferior second premolar wedges between the distal ridges of the buccal and the lingual cusps of the upper first premolar anteriorly, and the mesial ridges of the buccal and the lingual cusps of the upper second premolar posteriorly.

The lingual cusp of the upper first premolar wedges between the distal ridges of the buccal and the lingual cusps of the lower first premolar anteriorly, and the mesial ridges of the buccal and the lingual cusps of the lower second premolar posteriorly.

The lingual cusp of the upper second premolar wedges between the distal ridges of the buccal and the lingual cusps of the lower second premolar anteriorly, and the mesio-buccal cusp and the mesio-lingual cusp of the lower first molar posteriorly.

The mesio-buccal cusp of the lower first molar wedges between the distal ridges of the buccal and the lingual cusps of the upper second premolar anteriorly, and the mesio-buccal and the mesio-lingual cusps of the upper first molar posteriorly. The buccal cusp of the lower first molar wedges into the central fossa of the occlusal surface of the first upper molar, while the disto-buccal cusp wedges into the distal fossa of the occlusal surface of that tooth.

The mesio-lingual cusp of the upper first molar wedges into the central fossa of the lower first molar, while the disto-lingual cusp is received between the disto-lingual and the disto-buccal cusps of the lower first molar anteriorly, and the mesio-lingual and the mesio-buccal cusps of the lower second molar posteriorly.

The mesio-buccal cusp of the lower second molar wedges between the disto-buccal and the disto-lingual cusps of the upper first molar anteriorly, and the mesio-buccal and the mesio-lingual cusps of the upper second molar posteriorly. The disto-buccal cusp of the lower second molar is received into the central fossa of the upper second molar.

The mesio-lingual cusp of the upper second molar is received into the central fossa of the lower second molar; while the disto-lingual cusp, if fairly well developed, is received between the disto-lingual cusp and the disto-buccal cusp of the lower second molar anteriorly, and the mesio lingual and the mesio-buccal cusps of the lower third molar posteriorly. Frequently, however, the disto-lingual cusp of the upper second molar is very ill-developed, in which case the mesio-lingual cusp of the upper third molar is received between the mesio-buccal and the mesio-lingual cusps of the inferior third molar; that is, assuming that the upper and the lower third molars are of typical form.

In the case of the **temporary** teeth, the lower incisors and canines occlude with the upper incisors and canines in a similar manner to those of the permanent set. As, however, there are no premolars in the temporary dentition, the distal part of the lingual surface of the upper canine comes into contact with the buccal surface of the lower first temporary molar.

The lingual cusp of the upper first molar is received between the disto-lingual and disto-buccal cusps of the lower first molar anteriorly, and the mesio-buccal and mesio-lingual cusps of the lower second molar posteriorly.

The disto-buccal cusp of the lower first molar is received into the central fossa of the upper first molar.

The mesio-lingual cusp of the upper second molar is received into the central fossa of the lower second molar.

The buccal cusp of the lower second molar is received into the central fossa of the upper second molar, and its disto-buccal cusp into the distal fossa of the upper second molar; while the mesio-buccal cusp is received between the mesial marginal ridge of the occlusal surface of the upper second molar and the lingual and disto-buccal cusps of the upper first molar.

In the incisor region the cutting edges of the temporary teeth form curves corresponding to those of the permanent set, but they are comparatively less marked, while the planes formed by the grinding surfaces of the molars are as nearly as possible flat.

The shape of the permanent dental arches varies slightly in individuals with equally well-developed dentures. Those of which illustrations are given (*Plates V and VI*) may be regarded as fairly typical.

The points at which the interstitial surfaces of the various teeth touch their immediate neighbours are termed the **contact points.** These in the case of the molars and premolars are near the occlusal surface, and rather nearer the buccal than the lingual. The spaces between the teeth at their necks are the **interdental spaces,** which are filled by the **interdental papillæ.**

The long axes of the teeth are not all quite vertical. Their inclination varies with the individual, and more markedly with the race. In the negro type the premolars and incisors slant towards the lips considerably.

In a typical European denture the lower teeth from the canine back to the second molar are vertical, the third molar being inclined slightly forwards. The upper teeth from the first premolars to the second molars are vertical, the third molar being inclined slightly backwards, and the canines and incisors slightly forwards towards the lips, the incisors also having a slight mesial inclination.

CHAPTER V.

THE MOUTH.

THE simple and well understood term **mouth** is often discarded in favour of the term *oral cavity*. It is difficult to understand what is gained by this, for when the mouth is shut it is merely a potential and not an actual cavity, and the more homely phrase is therefore the less misleading of the two.

To fully understand the anatomy and physiology of the teeth, it is necessary to know something of the structures with which they are in immediate relationship, and which, directly or indirectly, assist them to fulfil their functions. With this in view, it is better to describe first the surface anatomy of the mouth, than to leave the student to conjecture from a description of the anatomy of the subjacent parts their connection with that aspect of the mouth with which, by inspection of the living subject, he can easily render himself familiar.

The mouth is opened and shut by the movements of the mandible, the mechanism of which will be described in a later chapter. The upper and lower margins of the anterior or external aperture of the mouth are formed by the **lips.** When the mouth is shut and the lips are in contact with each other, this aperture is a slightly curved horizontal fissure which extends from the canine tooth on one side to the canine tooth upon the other. Its exact relationship with the teeth can best be ascertained by drawing down the lower lip with the fingers, which, when the mouth is otherwise in repose, exposes as much of the labial surfaces of the lower incisors and canines as is left uncovered by the overlapping of the upper teeth, and reveals rather more than half of the labial surfaces of the upper central incisors, rather less than half of the labial surfaces of the upper lateral incisors, and only the extreme points of the cusps of the canines. The reason for the difference in the amount of surface of the central and lateral incisor teeth thus exposed, is partly that the line of apposition of the upper and nether lip is a slight curve, with its convexity upwards, and partly that the line of the cutting edges of the upper incisor teeth is a curve with its convexity downwards. It is thus seen that the upper incisor teeth come into contact with the internal surface of the lower lip—a fact of some importance to the dentist, and one with which any schoolboy of pugilistic tendencies is full well acquainted. The margins of the lips are lined with moist **mucous membrane** of reddish colour, continuous with that lining their internal surfaces. The extent of their exposed mucous surface varies with the individual, and, more markedly, with the race. It may be stated as a general truth—to which the exceptions are extremely rare—that the more the individual or the race tends to prognathism, the greater is the amount of mucous membrane exposed at the margins of the lips.

If the lower lip be drawn forcibly downwards so as to completely evert it, the mucous membrane lining it is seen to be continuous with that covering the lower of the two hard bony ridges from which the teeth emerge. These ridges are the upper and lower **alveolar ridges**, and the thin layer of comparatively soft tissue that covers them is the **gum**—hence the ridges themselves are popularly termed the *gums*. In passing from the lip to the lower part of the alveolar ridge immediately beneath the central incisor teeth, the mucous membrane forms a distinct fold, which is rendered the more prominent by the eversion of the lip; and which seems to be a point at which the lip is more firmly bound than elsewhere to the ridge. This fold is termed the **frænum of the lower lip.** Eversion of the upper lip shows a similar fold in the mucous membrane as it passes from the inner surface of the upper lip to the upper alveolar ridge. This is the **frænum of the upper lip.** The points at which the upper and lower lips become continuous are termed the **labial commissures.** Beneath the lower first premolar, and above the upper first premolar, where the mucous membrane passes from the alveolar ridges to the inner aspect of the cheek, are folds termed the **buccal fræna.** These are somewhat similar in appearance to the labial fræna, but each buccal frænum consists of two folds placed close together, and these, instead of passing from the alveolar ridges to points upon the cheek immediately opposite, can be traced for some little distance backwards before they become indistinguishable.

The mucous membrane lining the inner surface of the cheek is continuous with that lining the inner surface of the lips and the outer surface of the alveolar ridges. Opposite the upper second molar tooth it presents a minute papilla, in the centre of which is a depression which forms the **opening of the parotid** (*Stenson's*) **duct,** through which the saliva from the parotid gland is discharged into the mouth. Sometimes this opening is covered by a small triangular flap of mucous membrane, the apex of which is directed downwards and forwards. The outer surfaces of the upper and lower alveolar ridges are fluted—that is, marked by vertical ridges, which correspond to the insertion of the roots of the various teeth that the ridges support. The most prominent of these vertical ridges are those that correspond to the insertion of the roots of the canine teeth. Above the roots of the premolar teeth the upper alveolar ridge presents a marked depression or hollow, which is sometimes sufficiently deep to easily admit the tip of the little finger. This is the **canine fossa.** In passing the finger backwards along the outer surface of the lower alveolar ridge, it comes into contact just beneath the lower wisdom tooth with the well-defined edge of a bony upgrowth. This is the anterior edge of the **coronoid process** of the mandible. In tracing this upwards with the tip of the finger, one is suddenly checked by coming into contact with a bony outgrowth from the upper alveolar ridge. This arises some distance behind the canine fossa, and forms an arch of bone, the **malar arch,** which can be traced with the finger outwards and then backwards, passing externally to the coronoid process of the mandible, the anterior border of which checks further progress of the finger. If, when the finger is in contact with this latter process of bone in the living subject, the teeth are firmly clenched, the tip of the finger will be pressed inwards by the action of the **masseter** muscle, the anterior edge of which thus becomes clearly defined. The external surface of the superior alveolar ridge terminates just beyond the upper third molar, where it becomes continuous with the internal surface, and forms a rounded buttress—the **alveolar tuberosity.** Between this tuberosity and the coronoid process there is a small space, not large enough to admit more than the tip of the finger when the teeth are firmly clenched, but through which a small elastic tube can be easily passed—a fact of some importance to the surgeon. The potential cavity which exists between the inner surfaces of the lips and cheeks on the one side, and the teeth and alveolar ridges on the other, is termed the **oral vestibule.**

The **gum**, which is the soft tissue covering the alveolar ridges, has a festooned edge. It is closely applied to the necks of the teeth, and its margins in young subjects slightly overlap the enamel of their crowns. As it passes between the necks of the teeth from one side of the alveolar ridge to the other, it forms papillæ between the interstitial surfaces of the various teeth, where it projects upwards to fill what would otherwise be spaces between contiguous teeth. These papillæ are of considerable interest to the dental surgeon, because their function in the prevention of caries of the teeth is an important one—and an alteration in their appearance is often the earliest indication of certain pathological conditions that result in the premature loss of the teeth. These considerations alone render them worthy of some distinctive appellation, and the author would suggest **inter-dental papillæ** as an appropriate term.

When the mouth is opened to its fullest extent, the two rows of teeth displayed form its most striking feature. Arching across between the teeth of the upper row is the hard portion of the **roof.** This is formed by the inner surface of the upper alveolar ridge (the outer surface of which has already been described), and the hard palate. The inner surface of the upper alveolar ridge forms the sloping sides of the vault of the roof, and extends from the tuberosity behind the upper third molar on the one side, to the similar tuberosity upon the other. In the molar and premolar region it is almost vertical, but in the incisor region it extends upwards with a much more gradual slope, being at first almost horizontal. Unlike the outer, the inner surface of the upper alveolar ridge gives no indication of the whereabouts of the subjacent roots of the teeth, the only marked prominences upon its surface being the **rugæ.** These rugæ are more or less symmetrically arranged elevations of the mucous membrane, which cover the inner surface of the upper alveolar ridge in the incisor region. They consist of a longitudinal ridge, which extends from the inter-dental papilla between the central incisor teeth, and passing backwards becomes continuous with a ridge which marks the centre of the hard palate, and three transverse ridges which branch off from the longitudinal ridge and extend outwards towards the canine and premolar teeth. Their appearance is well illustrated in *Plate IV.*, *Fig. B.* No function has been assigned to them, but it is probable that they assist the tongue in the rotation of morsels of food during mastication; and in infants, before the teeth are cut, facilitate the prehension of the nipple.

The **hard palate** is the flattened surface which forms the highest part of the roof of the mouth. Its posterior border extends transversely across the mouth from the alveolar tuberosities. This border forms two symmetrical curves with their concavity backwards, which meet in a point midway between the tuberosities to form the **post-nasal spine**—which terminates the central ridge before mentioned. As the roof of the mouth is continued backwards by the **soft palate,** the posterior border of the hard palate is often indistinguishable to the eye. The finger, however, easily distinguishes between the hard and soft palates, and with it the shape of the posterior border of the former is easily made out.

The **palatal ridge,** which divides the hard palate into lateral halves, is, when carefully examined, found to consist really of two ridges running side by side, and divided by a very narrow depression. Sometimes the mucous membrane dips down into this, in which case it is discernible to the eye ; but it generally bridges it over, when it can only be distinguished by the finger. The hard palate is slightly depressed upon either side of the palatal ridge (or to be more correct, ridges), to form fossæ, which seem the deeper on account of the steep sides of the alveolar ridge, which forms their external margins.

The remainder of the roof of the mouth is formed by the **soft palate,** which is continuous with the hard. Its surface is concave, its highest point being where it is attached to the hard palate, where it is almost horizontal, but sloping rapidly it becomes nearly vertical posteriorly, and forms an incomplete partition between the cavity of the mouth and that of the pharynx. It terminates posteriorly in a free margin, which forms the upper margin of the posterior or internal aperture of the mouth. This margin is prolonged into a conical pendulous body—the **uvula.** The depth of the soft palate (viz., the distance from its posterior margin to the posterior border of the hard palate) varies considerably in different individuals. As a result of this, in some the uvula can easily be seen without depressing the tongue, while in others the tongue has to be very firmly depressed to bring it into view at all. It is worthy of notice that in those individuals who have naturally an overhung bite—in other words, whose upper front teeth project abnormally beyond the lower, the soft palate is of more than average depth—and appears to be deeper than it really is, in consequence of the prominence of the front teeth.

Passing down the centre of the soft palate, a whitish line is perceptible continuous with the palatal ridge, and extending from it to the uvula. At the base of the uvula the posterior margin of the soft palate splits to form two prominent folds on each side. These are the **anterior** and **posterior pillars of the fauces.** The anterior pillars of the fauces are best seen by well depressing the tongue. Arising below from the floor of the mouth and the inner surface of the extremities of the lower alveolar ridge, they pass upwards to form an arch, from the roof of which the uvula hangs down like a stalactite. The sides of this arch form the lateral boundaries of the posterior aperture of the mouth. Just beyond them are the **tonsils**, which separate them from the posterior pillars of the fauces.

Beneath the soft palate just behind and internal to the alveolar tuberosities, small bony prominences can be felt by the finger. These are the **hamular processes** of the internal pterygoid plates of the sphenoid bone. From them, extending outwards and downwards to the posterior extremities of the inner surface of the lower alveolar ridge, the **pterygo-maxillary ligaments** can be traced. The situation of these is best seen when the mouth is opened to its utmost extent, because they then form two prominent folds upon the soft palate, over which the mucous membrane passes from the soft palate to become continuous with that lining the cheeks.

The concavity of the arch formed by the lower teeth is occupied by the **tongue**, a large extent of the upper surface of which organ is visible when the mouth is fully opened. This surface is covered with mucous membrane, which is peculiar to it. It feels rougher to the finger than the mucous membrane of the lips and cheeks, and the unaided eye can perceive that this roughness is due to minute elevations or papillæ. A slight furrow divides this surface into lateral halves. When the tongue is at rest within the inferior dental arch, this furrow forms an irregular depression extending backwards in a zig-zag manner from near the tip of the tongue (viz., that part just behind the lower incisor teeth) over the dorsum, which is that part which arches across between the molar teeth. When the tongue is protruded, this furrow straightens out and forms a well-marked median depression—the **raphé**—" which indicates the bilateral symmetry of the tongue." Rather less than the anterior two-thirds of the upper surface of the tongue is visible on looking into the widely-opened mouth.

By raising the tongue the inner aspect of the lower alveolar ridge and the floor of the mouth are brought into view.

The mucous membrane covering the under surface of the tongue, unlike that of the upper, is smooth and shining, and the transition from the one to the other is very abrupt. Passing from the lower alveolar ridge in the middle line to the under surface of the tongue, is the **frænum linguæ.** This is very well defined when the tongue is forcibly raised, and can be traced almost to its tip. Upon each side of the frænum linguæ near its alveolar margin, is a well-marked papilla. Each of these is marked by a depression—the **opening of the sub-maxillary** (*Wharton's*) **duct,** from which saliva can be seen to flow in the living subject. From these papillæ, extending outwards along the floor of the mouth between the alveolar ridge and the tongue, are well-marked ridges of mucous membrane—one on each side. These mark the position of the **sub-lingual glands.** The openings of the ducts of Rivinus are also here, but are not visible to the naked eye.

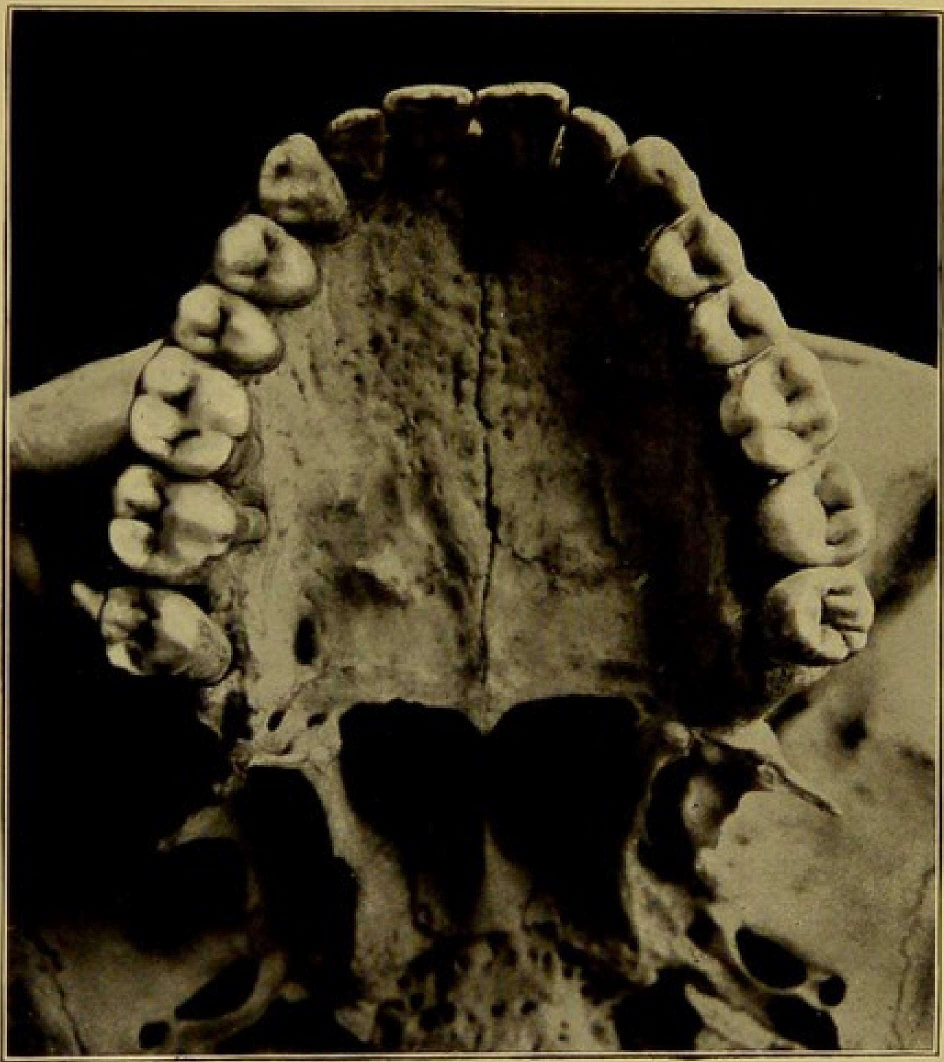
The veins which are so clearly visible through the mucous membrane on the under surface of the tongue on each side of the frænum, and converging towards it, are the **ranine veins.**

External to these, and running a course nearly parallel to them, are the **gustatory nerves,** which can be distinctly traced almost to the tip of the tongue, because they lie immediately beneath the mucous membrane, which is raised in well-marked ridges by them.

The inner surface of the lower alveolar ridge is covered with mucous membrane, continuous with that lining the under surface of the tongue. The ridge is deepest in the molar region, where it bulges considerably into the mouth. The extent of this bulging can best be appreciated by sweeping the finger round the inner surface of the ridge as low down as the reflection of the mucous membrane will allow, when the bony ridge will be found to overhang the tip of the finger very considerably at those points which correspond to the insertion of the roots of the second and third molar teeth. In the premolar region the inner surface of the alveolar ridge is almost vertical. In the incisor region there is a thickening over the roots of the teeth, that causes a bulging inwards of the ridge somewhat similar to that in the molar region, but it is not nearly so pronounced. Underneath this, in the middle line, if the tip of the finger be pressed down at the point where the frænum linguæ appears to arise from the alveolar ridge, two little prominences of bone can be distinctly felt. These are the **genial tubercles.**

The anatomical landmarks described in this chapter should be carefully noted by the student, as they will enable him to form an accurate idea of the relationship to the surface of the mouth, of the various structures which will be described in later chapters.

PLATE VI.



CHAPTER VI.

THE BONY FRAMEWORK OF THE JAWS.

THE bones in which the teeth are embedded, and which determine the configuration of the mouth, are the **maxillary bones.** These are three in number, two superior and one inferior. The **mandible,** or *inferior maxilla*, in itself constitutes the whole of the bony part of what is popularly termed the *lower jaw*. The **superior maxillary** bones, besides forming the bony foundation of the whole of the upper alveolar ridge and the greater part of the hard palate, contribute largely to the formation of the face. It is obvious, therefore, that a detailed description of these bones is necessary here; but the student is strongly recommended to render himself familiar also with the other bones of which the skull is composed—for a description of these he must refer to a text-book of osteology or of general anatomy.

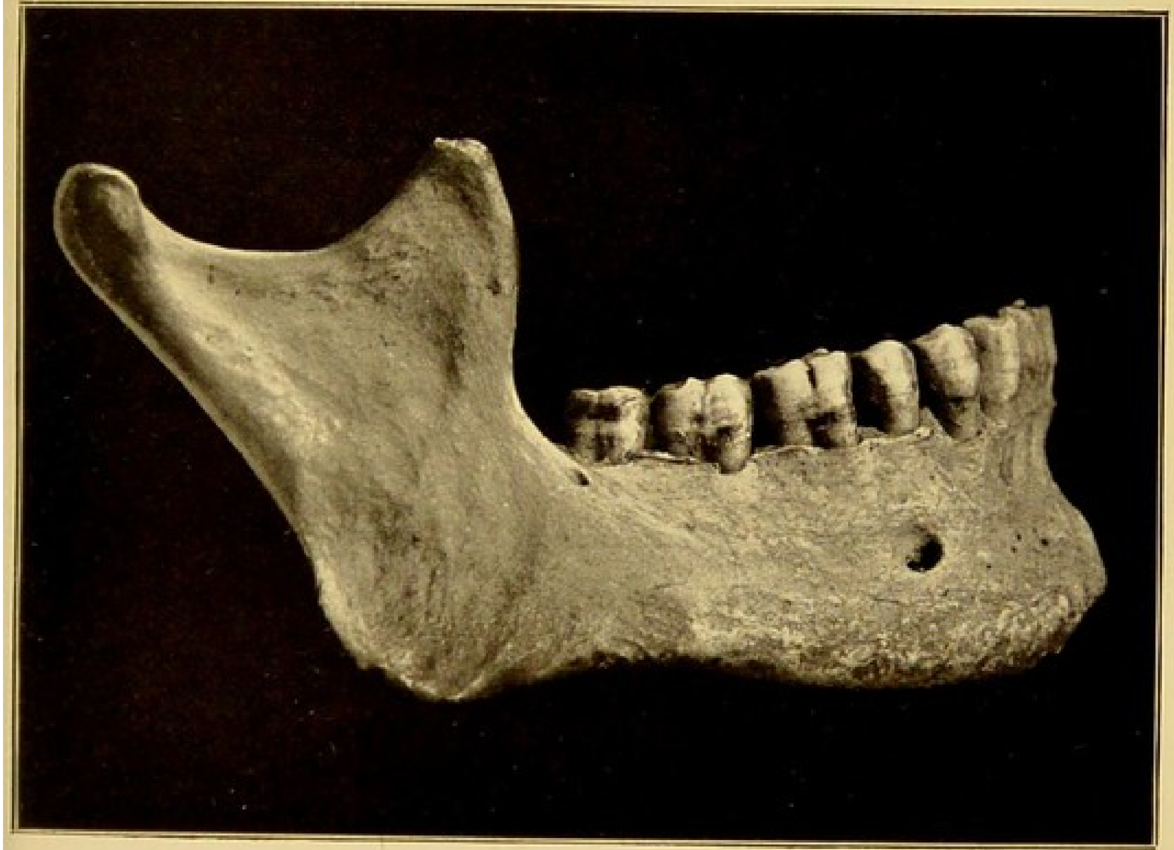
Plate V. illustrates the *facial* aspect of the maxillary bones. It shows that the prominences observed upon the external surfaces of the alveolar ridges in the mouth of the living subject, correspond to similar ridges in the bones of the jaws, in which the teeth are now seen to be embedded. From this it is an easy inference that the soft tissue covering the bony foundation of the alveolar ridges is of no great thickness, and is evenly disposed. The extent of exposure of the necks of the teeth indicates the depth of the soft tissue at the margins of the alveolar ridges. The fossa above the premolar teeth (**canine fossa**) is well marked in the skeleton, and the outgrowth of bone above the first upper molar tooth and the lower border of the malar bone will be recognised as forming the **malar arch** mentioned in the previous chapter. The **coronoid process** of the mandible, with the anterior border of which the finger came into contact in tracing backwards the external surface of the lower alveolar ridge, as described in the previous chapter, is clearly seen in the illustration.

Plate VI. is a photograph of the *palatal* aspect of the superior maxillary and **palate** bones. The line of union of the maxillary bones is well marked, running directly backward from between the central incisor teeth towards the mesial projection (**post-nasal spine**) at the posterior border of the distal margin of the bony palate. The distinction between that part of the palate formed by the maxillary and palate bones, is well marked in the photograph, for not only is the line of union fairly discernible, but the surface of the former is seen to be much more rugged than that of the latter. It should be noticed that the rugæ observable in the palate in the living subject are not to be seen in the dry bone.

Four bones, therefore, enter into the formation of the hard palate, viz., the two superior maxillary, and the two palate bones. Just posterior and internal to the alveolar tuberosities, the **hamular processes** of the internal pterygoid plates of the sphenoid bone are to be seen, which processes the reader will remember can be felt beneath the soft palate. With these landmarks so clearly defined, the student should have no difficulty in understanding the relationship of the deeper structures entering into the formation of the mouth, to those surface markings with which he is already familiar.

The MANDIBLE, or *Inferior Maxilla* (*Plate VII.*), is the thickest and strongest bone of the face, and forms

PLATE VII.



the contour of the lower part of it. It consists of a curved horizontal portion, the **body,** and two **rami,** which ascend from the back part of the body, nearly at right angles to it. It is extremely movable upon the rest of the skull, with which it articulates by means of a pair of **condyles.**

The **body** presents for examination two surfaces and two borders.

The *external* surface is convex from side to side, concave from above downwards. In the median line is a vertical ridge, which extends from the upper to the lower border of the bone, and indicates the point of junction of the two pieces of which the bone is composed at an early period of life, and is hence named the **symphysis.** This ridge is continued below into a triangular eminence—the **mental process,** which forms the *chin*, a feature peculiar to mankind. On either side of the symphysis, just below the roots of the incisor teeth, is a depression—the **incisor fossa**, which is the point of attachment of a muscle termed the *levator labii inferioris.* External to this, at a point midway between the upper and lower borders, and vertically beneath the contact point of the first and second premolar teeth, is the **mental foramen**, which is the termination of the *inferior dental canal*, and gives passage to the *mental nerve* and *artery.* Close below the foramen, running from the mental prominence upwards and backwards to the anterior margin of the ramus, is the **external oblique line.** This is a ridge of bone well marked posteriorly, where it is continuous with the anterior edge of the ramus, but becoming more indistinct anteriorly—where the *depressor anguli oris* and *depressor labii inferioris* muscles are attached. The *platysma myoides* muscle is also inserted along the lower part of this surface of the body of the lower jaw.

The *internal* surface is concave from side to side, convex from above downwards. In the middle line a linear depression corresponds to the symphysis externally; on either side of this depression are prominent tubercles, two on each side placed one above the other. These are the **genial tubercles.** The upper pair, which the student will remember can be felt from within the mouth in the living subject, afford attachment to the *genio-hyoglossi* muscles, and the lower pair to the *genio-hyoid* muscles. Sometimes the tubercles on each side are blended into one, or they all unite into one irregular eminence of bone, or nothing but an irregularity may be seen on the surface of the bone at this point. On either side of the genial tubercles is an oval depression—the **sub-lingual fossa,** for lodging the *sub-lingual gland*, and beneath the fossa a rough depression on each side, which gives attachment to the anterior belly of the *digastric* muscle. The **mylo-hyoid ridge,** or *internal oblique line*, runs from beneath the genial tubercles upwards and backwards to the ramus. It gives attachment to the *mylo-hyoid* muscle. It is most prominent just beneath the molar teeth, and forms the "bulging" of the internal surface of the lower alveolar ridge, that was remarked upon in the previous chapter. Just above the posterior extremity of this ridge, the *superior constrictor* muscle of the pharynx, and the *pterygo-maxillary* ligament are attached. It will be remembered that the pterygo-maxillary ligament raises a fold on the soft palate in the living subject when the mouth is widely opened, and can be traced from its attachment to the hamular process of the internal pterygoid plate of the sphenoid bone. Below the mylo-hyoid ridge is an oblong depression—the **sub-maxillary fossa**, for the lodgment of the *sub-maxillary gland.* The external oblique line and the internal oblique line divide the body of the bone into a superior or alveolar, and an inferior or basilar portion. It will be seen, therefore, that what was described in the previous chapter as the lower alveolar ridge, corresponds to the alveolar portion of the body of the mandible.

The *superior*, or alveolar border, corresponds to the crest of the lower alveolar ridge. From it the teeth emerge, and if these be removed, the alveoli which contain their roots are brought into view. It is to be noticed that there is a separate socket for each fang where the teeth have more than one, these sockets constituting the **alveoli**; and that the free edges of the inter-dental septa are convex, whereas the free margins of the outer and inner alveolar plates (which form the outer and inner surfaces of the bony parts of the alveolar ridges) are festooned, the concavities of the festoons being in the intervals between the inter-dental septa. As a result of this the bony sockets of the teeth rise to a higher level between contiguous teeth than elsewhere, this being particularly well marked between the incisor teeth.

It is noticeable that the fangs are not actually united to the **alveolar process**, as the bone is termed which forms the sockets, but that an appreciable space intervenes. This in the recent subject is filled with connective tissue, the **dental periosteum.** This periosteum is attached on one side to the cementum of the roots of the teeth, and on the other to the bony walls of the alveoli. It becomes continuous at the margins of the alveoli with the periosteum of the jaws. In the young subject the dental periosteum is comparatively thick, becoming thinner and tougher with increasing age. In the injected specimen it is seen to be extremely vascular, and this vascularity endows it with a resiliency that is usually, and erroneously, attributed to the tissue itself. The dental periosteum thus forms an admirable buffer, and is the active agent that ensures the exact and comfortable occlusion of the teeth. It is more firmly attached to the cementum of the teeth than to the socket wall.

The method of implantation, or *articulation*, as it was termed by John Hunter, is termed **gomphosis.** The inner surfaces of the sockets have a spongy appearance, due to numerous perforations, the largest of these being at the bottom of the sockets, where the vessels and nerves that supply the dental pulps and periosteum come through.

The *buccinator* muscle is attached to the outer alveolar plate as far forward as the first molar tooth.

The *inferior* border of the body of the mandible is rounded, thicker in front than behind, and just where the body joins the ramus, presents a groove over which the *facial artery* turns.

The **rami** are of quadrilateral form. Each presents for examination two surfaces, four borders, and two processes. The external surface is flat, marked with ridges, and gives attachment throughout nearly the whole of its extent to the *masseter* muscle. The internal surface presents about its centre the oblique **aperture of the inferior dental canal,** for the passage of the *inferior dental vessels* and *nerves.* The margin of this opening is irregular; it presents in front a prominent ridge surmounted by a sharp spine, the **lingula,** which gives attachment to the *lateral ligament* of the lower jaw; and at the lower and back part a notch leading to a groove, the **mylo-hyoidean,** which runs obliquely downwards to the back part of the sub-maxillary fossa, and lodges the *mylo-hyoid vessels* and *nerve.* Behind the groove is a rough surface for the insertion of the *internal pterygoid* muscle. The **inferior dental canal** runs obliquely downwards and forwards in the substance of the ramus, and then horizontally forward in the body. It is here placed under the alveoli, with which it communicates by the above-mentioned foramina. On arriving at the incisor teeth it turns back to communicate with the mental foramen, giving off two small canals, which run forward to be lost in the cancellous tissue of the bone beneath the incisor teeth. This canal in the posterior two-thirds of the bone is situated nearer the internal surface of the jaw, and in the anterior third nearer its external surface. Its walls are composed of compact tissue at either extremity, and of cancellous tissue in the centre. It contains the *inferior dental vessels* and *nerves*, from which branches are distributed to the teeth through small apertures at the base of the alveoli. It occasionally runs very close to the root of the lower third molar tooth; so close, indeed, that instances are recorded of the removal of that tooth being followed by impairment of function of the inferior dental nerve, which had suffered injury by the extraction.

The upper border of the ramus is thin, and presents two processes separated by a deep concavity—the **sigmoid notch.** Of these processes the anterior is the **coronoid,** the posterior the **condyloid.**

The **coronoid process** is a thin flattened triangular eminence, which gives attachment by its apex to the *temporal* muscle. Its external surface is smooth, and gives attachment to the *masseter* muscle. Its internal surface gives attachment to the *temporal* muscle, and presents the commencement of a longitudinal ridge, which is continued to the posterior part of the alveolar process. On the outer side of this ridge is a deep groove continued below on the outer side of the alveolar process; this ridge and part of the groove afford attachment above to the *temporal*, below to the *buccinator* muscles.

The **condyloid process** is narrower, thicker, and shorter than the coronoid, and terminates in an oblong rounded head, the **condyle**, just beneath which is a constricted portion, the **neck.** The condyle is a transversely elongated convex articular process, the major axis of which is directed obliquely,* so that if prolonged it would meet with that of its fellow near the anterior margin of the foramen magnum. The articular surface extends further on the posterior than on the anterior surface.

The **neck** of the condyle is flattened from before backwards, and strengthened by ridges which descend from the fore part and sides of the condyle. Its lateral margins are narrow, and present externally a tubercle for the *external lateral ligament.* Its posterior surface is convex ; its anterior is hollowed out on its inner side by a depression, the **pterygoid fossa**, for the attachment of the *external pterygoid* muscle.

The lower border of the ramus is thick, straight, and continuous with the body of the bone. At its junction with the posterior border is the **angle** of the mandible, which is marked by the rough oblique ridges which give attachment to, and testify to the power of, the *masseter* and *internal pterygoid* muscles. The *stylo-maxillary ligament* is attached to the bone between these muscles.

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* John Hunter wrote in "The Natural History of the Human Teeth" with reference to the condyle : "Its external end is turned a little forward, and its internal a little backward ; so that the axes of the two condyles are neither in the same straight line, nor parallel to each other ; but the axis of each condyle, if continued backwards, would meet, and form an angle of about one hundred and forty-six degrees ; and lines drawn from the symphysis of the chin to the middle of the condyle would intersect their longest axis at nearly right angles. There are, however, some exceptions for in a Lower Jaw, of which I have a drawing, the angle formed by the supposed continuation of the two axes, instead of being an angle of one hundred and forty-six degrees, is one of one hundred and ten only.

PLATE VIII.

Fig. A.

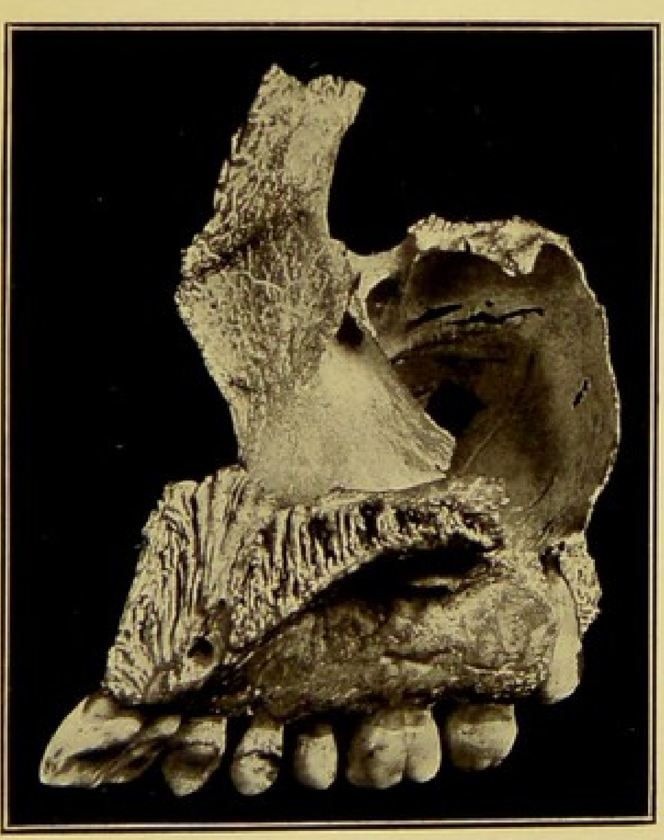

Fig. B.

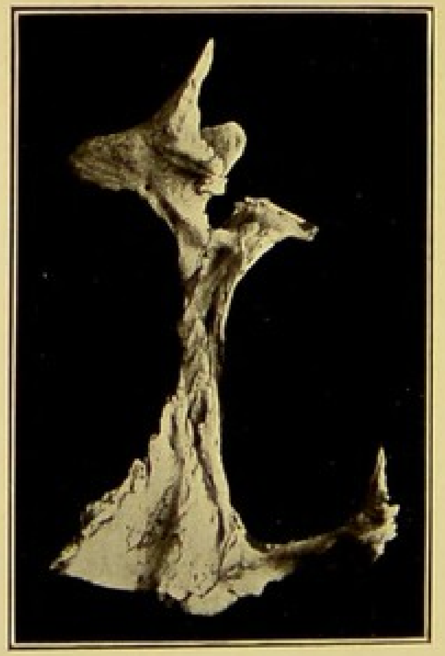

Fig. C.

The anterior border of the ramus is thin above, thicker below, and continuous with the external oblique line. It forms a prominent landmark in the surface anatomy of the mouth. The posterior border is thick, smooth, and rounded, and covered by the *parotid gland.*

The **sigmoid notch** separating the two processes, is a deep semilunar depression, crossed by the *masseteric artery* and *nerve.*

The angle of the jaw in the adult is usually about one hundred and twenty degrees. (Quain). It varies, however, with age and other circumstances which will be discussed in another chapter.

THE SUPERIOR MAXILLA (*Plate VIII, Fig. A*) is the next largest bone of the face to the mandible. With its fellow of the opposite side and the two palate bones, it forms the whole of the upper jaw. It presents for examination a **body,** and four processes, **malar, nasal, alveolar,** and **palatine.**

The **body** is somewhat cuboid, and is hollowed out in the interior to form a cavity of variable size—the **antrum of Highmore.** It presents four surfaces for examination —a facial, a zygomatic, an orbital, and an internal.

The *facial* surface is directed forwards and outwards. Just above the roots of the incisor teeth is a depression —the **incisor fossa.** This gives origin to the *depressor alæ nasi* muscle, and above and just external to it the *compressor nasi* muscle arises. The eminence over the root of the canine tooth, and the depression above and behind it (**canine fossa**), have already been mentioned. The latter gives origin to the *levator anguli oris* muscle. Above the canine fossa is the **infra-orbital foramen,** the termination of the infra-orbital canal, which transmits the *infra-orbital nerve* and *artery.* Above the infra-orbital foramen is the margin of the orbit, which affords partial attachment to the *levator labii superioris proprius* muscle (*Fig.* 47, *p.* 108).

The *zygomatic* surface is directed backwards and outwards, and is marked by foramina which form the **openings** of the **posterior dental canals**, which transmit the *posterior dental vessels* and *nerves* to the substance of the bone. At the lower part of this surface is the **alveolar tuberosity**, which was noted in the chapter on the surface markings of the mouth. It presents a roughness on the inner side, where it articulates with the tuberosity of the palate bone. Immediately above the rough surface is a groove which the palate bone converts into a canal—the **posterior palatine canal.**

The *orbital* surface forms part of the floor of the orbit. It is bounded internally by an irregular margin, which articulates in front with the lachrymal, in the middle with the ethmoid, and behind with the palate bone; externally by a smooth rounded edge, which helps to form the **spheno-maxillary fissure**; and anteriorly by part of the circumference of the orbit, which is continuous on the inner side with the nasal, on the outer side with the malar process. This surface is of interest to the dental surgeon, as it sometimes gets pushed upwards, and the eye in consequence displaced, by solid growths in the antrum, which he may have to differentiate from empyema of that cavity due to diseased teeth.

Along the middle line of the orbital surface is a deep groove—the **infra-orbital**, for the passage of the *infra-orbital nerve* and *artery*. This terminates in a canal, which divides into two, one of which opens just below the orbit (**infra-orbital foramen**), and the other, which runs in the substance of the anterior wall of the antrum, is called the **anterior dental canal**, and transmits the *anterior dental vessels* and *nerves* to the front teeth. The *inferior oblique* muscle of the eye arises at the inner and fore part of the orbital surface.

The *internal* surface (*Plate VIII, Fig. B*) is unequally divided into two parts by a horizontal projection of bone —the **palate process**; the portion above forming the outer wall of the nose, the portion below forming the lateral half of what was described in the previous chapter as the inner surface of the superior alveolar ridge. The superior division of this surface presents a large irregular opening leading into the antrum of Highmore. At the upper border of this aperture are numerous broken cellular cavities which, in the articulated skull, are closed in by the ethmoid and lachrymal bones. Below the aperture is a smooth concavity which forms part of the **inferior meatus** of the nose, traversed by a fissure, the maxillary fissure, which runs from the lower part of the orifice of the antrum obliquely downwards and forwards and receives the maxillary process of the palate bone. Behind it is a rough surface which articulates with the perpendicular plate of the palate bone, traversed by a groove already mentioned. In front of the opening of the antrum is a deep groove converted into a canal by the lachrymal and inferior turbinate bones, which form the **lachrymal**, or *nasal* **duct.** More anteriorly is a well marked rough ridge, the **inferior turbinate crest,** for articulation with the inferior turbinate bone. The concavity above this ridge forms part of the **middle meatus** of the nose; whilst that below it forms part of the inferior meatus.

The **antrum of Highmore,** or *maxillary sinus*, is a pyramidal cavity with its apex directed outwards. Its walls are very thin, the roof being formed by the orbital plate; its floor by the bone closing in the apices of the alveoli of the molar teeth, the fangs of which sometimes project into its cavity; its anterior wall by the facial, and its posterior by the zygomatic surface. Its inner wall or base presents in the disarticulated bone a large irregular aperture, which communicates with the nasal fossa.

The margins of this aperture are thin and ragged, and the aperture itself is much contracted by its articulation with the ethmoid above, the inferior turbinate below, and the palate bone behind. In the articulated skull this cavity communicates with the middle meatus of the nose, generally by two small apertures left between the above-mentioned bones. In the recent state, usually only one small opening exists near the upper part of the cavity, sufficiently large to admit the end of a probe, the other being closed by the lining membrane of the sinus. Crossing the cavity of the antrum are often seen projecting laminæ of bone similar to those seen in the sinuses of the cranium. On its posterior wall are the **posterior dental canals**, transmitting the *posterior dental vessels* and *nerves* to the teeth. Projecting into the floor are several conical processes corresponding to the fangs of the first and second molar teeth. The number of teeth the fangs of which are in relation with the floor of the antrum is variable. Salter said that "the antrum may extend so as to be in relation to all the teeth of the true maxilla, from the canine to the dens sapientiæ." This variability in the extent of the cavity is very marked. Sometimes it extends so far in the direction of its apex, that the malar bone may be said to enter into its formation. In the recent state the antrum is lined with ciliated epithelium, continuous with that lining the nasal fossæ.

The **malar process** is the triangular eminence that articulates with the malar bone. In front it forms a part of the facial surface, above it is rough and serrated for articulation with the malar bone, except when the cavity of the antrum extends into that bone, in which case there is a large opening through which the interior of the antrum is visible (*Plate VIII, Fig. A*). Below, a prominent ridge marks the division between the facial and zygomatic surfaces, a ridge that forms part of the malar arch mentioned in the previous chapter. A few fibres of the *masseter* muscle arise from this process.

The **nasal process** is a thick triangular plate of bone which projects upwards, inwards, and backwards by the side of the nose, forming part of its lateral boundary. Its external surface gives attachment to the *levator labii superioris alæque nasi*, the *orbicularis palpebrarum*, and the *tendo oculi* (*Fig.* 47, *p.* 108). Its internal surface forms part of the outer wall of the nose. It articulates above with the frontal bone, and presents a rough uneven surface, which articulates with the ethmoid bone, closing in the anterior ethmoidal cells. Below this is a transverse ridge—the **superior turbinate crest,** which articulates with the middle turbinate bone, and below this a smooth concave surface, which forms part of the **middle meatus.** The anterior border of the nasal process is thin, and directed obliquely downwards and forwards. It articulates with the nasal bone. Its posterior border is thick and hollowed into a groove for the **lachrymal duct**; of the two margins of this groove the inner one articulates with the lachrymal bone, the outer one forms part of the circumference of the orbit. Just where the latter joins the orbital surface is the **lachrymal tubercle.**

The **alveolar process** is the thickest and most spongy portion of the bone. It forms the bony part of the upper alveolar ridge described in the last chapter. Its alveoli have a general resemblance to the alveoli of the mandible, the most marked difference being that there are three sockets for the roots of the first and second, and sometimes the third molars. The inner plate of the alveolar ridge is stronger than the outer, and has the additional support of the palate process.

The **palate process** projects horizontally inwards from the inner surface of the bone. It is much thicker in front than behind. Its upper surface is concave and smooth, and forms part of the floor of the nose. In front is seen the upper **orifice** of the **anterior palatine canal,** which leads into a fossa formed by the junction of the two maxillary bones, situated immediately behind the incisor teeth. It transmits the *anterior palatine vessels*, the *naso-palatine nerves* passing through the inter-maxillary suture. The inferior surface is also concave, and is rough and uneven, and forms part of the roof of the mouth. It is perforated by numerous foramina for the passage of nutrient vessels, channelled at the back part of its alveolar border by a longitudinal groove for the transmission of the *posterior palatine vessels*, and a large nerve, and presents little depressions for the lodgment of *palatine glands.* This surface presents anteriorly the lower orifice of the anterior palatine canal, the **anterior palatine fossa.** In some bones a delicate linear suture may be seen extending from the anterior palatine fossa to the interval between the lateral incisor and the canine tooth. This marks out the **inter-maxillary,** or *incisive,* bone, which in some animals exists permanently as a separate piece. It includes the whole thickness of the alveolus, the corresponding part of the floor of the nose, and the anterior nasal spine, and contains the sockets of the incisor teeth. The outer border of the palate process is incorporated with the rest of the bone. The inner border is thicker in front than behind, and is raised above into a ridge which, with the corresponding ridge on the opposite bone, forms a groove for the reception of the vomer. The lower edge of this border, when joined to the opposite bone, forms the ridge with the central depression which was mentioned in the previous chapter as the median ridge of the hard palate. The anterior margin is bounded by the thin concave border of the opening of the nose prolonged forwards internally into a sharp process, forming, with a similar process of the opposite bone, the **anterior nasal spine.** The posterior border is serrated, for articulation with the horizontal plate of the palate bone.

The PALATE BONES form the back part of the hard palate (*Plate VI*).

Each consists of a horizontal and vertical plate united at right angles, and of three processes, the **pyramidal,** the **orbital,** and the **sphenoidal** (*Plate VIII, Fig. C*).

The *horizontal* plate has two surfaces and four borders. The upper surface, which is smooth and concave laterally, forms the back part of the nasal floor. The under surface forms the back of the vault of the hard palate, and serves for the attachment of the *tensor palati* muscle.

The four borders of this plate are the anterior, posterior, internal, and external.

The anterior articulates with the palate process of the superior maxillary bone. The posterior forms the lateral half of the posterior margin of the hard palate. It is thin and deeply concave, and forms the crescentic edge described in the chapter on the surface anatomy of the mouth (*Plate VI*). The inner extremity of this border is prolonged backwards to form with that of the opposite bone the **palatine,** or **post-nasal, spine,** to which the *azygos uvulæ* muscle is attached. The inner border is thick and serrated for articulation with its fellow of the opposite side, and with the vomer. The external border is the junction of the horizontal and vertical plates. The junction is marked by the **groove** of the **posterior palatine canal.**

The *vertical* plate has two surfaces, internal or nasal, and external. The nasal surface is unequally divided by a transverse ridge, the **inferior turbinate crest,** which separates the middle from the inferior meatus of the nose. At the upper end of the surface is a less marked ridge, the **superior turbinate,** or *ethmoidal* **crest.** The external surface is grooved, which groove helps to form, with the superior maxillary bone, the **posterior palatine canal.**

The **pyramidal process** fits into the cleft between the pterygoid plates of the sphenoid bone.

The **orbital process** forms the posterior angle of the floor of the orbit. It is hollow, and helps to form the **posterior ethmoidal cells.**

The **sphenoidal process** is a projection from the upper and posterior part of the vertical plate. Its extremity touches the alæ of the vomer.

THE VOMER forms the posterior part of the mesial septum of the nares. It is of some importance to the dentist and the dental student, because, stretching as it does from the sphenoid to the maxillary and palate bones, it has to be taken into consideration in deformities and lesions of the hard palate. It is a thin somewhat quadrilateral plate of bone. Its lateral surfaces are smooth, and marked by a groove for the *naso-palatine vessels* and *nerve.* Its superior border splits to form two **alæ,** which embrace the rostrum of the sphenoid bone. The anterior border is grooved for the cartilage that helps to form the nasal septum, and also articulates with the ethmoid bone. The inferior border articulates with the nasal crest of the maxillary and palate bones. The posterior border is thin and concave, and forms the posterior margin of the septum of the nares.

Chapter VII.

THE TEMPORO-MANDIBULAR JOINT,
and the Muscles concerned in its Movements

THE following terse description by John Hunter of the parts immediately concerned in the articulation of the mandible, has not been surpassed by any recent writer.

"Just under the beginning of the Zygomatic Process of each Temporal Bone, before the external meatus auditorius, an oblong cavity may be observed; in direction, length, and breadth, in some measure corresponding with the condyle of the lower jaw. Before, and adjoining to this cavity, there is an oblong eminence, placed in the same direction, convex upon the top, in the direction of its shorter axis, which runs from behind forwards; and a little concave in the direction of its longer axis, which runs from within outwards. It is a little broader at its outer extremity; as the outer corresponding end of the condyle describes a larger circle in its motion than the inner. The surface of the cavity, and eminence, is covered with one continued smooth cartilaginous crust, which is somewhat ligamentous, for by putrefaction it peels off, like a membrane, with the common periosteum. Both the cavity and eminence serve for the motion of the condyle of the lower jaw. The surface of the cavity is directed downward; that of the eminence downward and backward, in such a manner that a transverse section of both would represent the italic letter *ƒ* (*Fig.* 36). Though the eminence may, on a first view of it, appear to project considerably below the cavity, yet a line drawn from the bottom of the cavity, to the most depending part of the eminence, is almost horizontal, and therefore nearly parallel with the line made by the

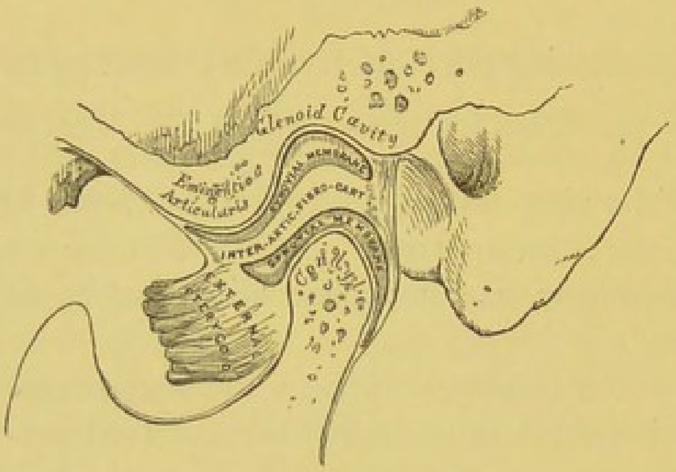

Fig. 36.

grinding surfaces of the teeth in the upper jaw;* and when we consider the articulation farther, we shall find that these two lines are so nearly parallel that the condyle moves almost directly forwards in passing from the cavity to the eminence; and the parallelism of the motion is also preserved by the shape of an intermediate cartilage."

"In this joint there is a movable cartilage, which,

* The student who has not yet had the opportunity that the dissecting room affords of verifying Hunter's description, will be inclined to doubt its accuracy, for in the dry bone the eminence does "project considerably below the cavity." He must remember, however, that the description applies to the parts when they are covered with cartilage. Of its absolute accuracy he can convince himself later on by dissection; or, at any time, by experiment, for if he protrude his own mandible while his thumbs are placed upon its angles and his forefingers upon its condyles, he will find that the very slight downward movement of the condyles corroborates Hunter's assertion.

though common to both condyle and cavity, ought to be considered rather as an appendage of the former than of the latter, being more closely connected with it; so as to closely accompany it on its motion along the common surface of both the cavity and eminence. This cartilage is nearly of the same dimensions with the condyle, which it covers; is hollowed on its inferior surface to receive the condyle; on its upper surface it is more unequal, being moulded to the cavity and eminence of the articulating surface of the temporal bone, though it is considerably less, and is therefore capable of being moved from one part of that surface to another. Its texture is ligamento-cartilaginous." This structure, which is described by recent writers as the **inter-articular fibro-cartilage** (*Fig.* 36), is attached by its edges to the capsular ligament of the jòint, and in front to the tendon of the external pterygoid muscle. It is roughly oval in form, broadest transversely, thickest posteriorly, and thicker at its circumference than at its centre, where it is sometimes perforated. It divides the joint into two cavities, each of which has its separate synovial membrane. These of course communicate with one another when the inter-articular fibro-cartilage is perforated.

The **Capsular Ligament** (*Fig.* 37) is attached above to the circumference of the glenoid cavity, and articular eminence, and below to the neck of the condyle. It is strengthened externally by a strong band of fibres passing from the tubercle of the zygoma to the outer and posterior border of the neck of the condyle. This strengthening band is usually described as the **External Lateral Ligament** (*Fig.* 38).

The **Internal Lateral Ligament** (*Fig.* 37) is quite distinct from the capsule of the joint, and passes from the spine of the sphenoid bone to the inner border of the inferior dental foramen of the mandible.

The **Stylo-Mandibular** or **Stylo-Maxillary Ligament,** (*Fig.* 37) extends from the styloid process of the temporal bone to the angle and posterior border of the ramus of the mandible.

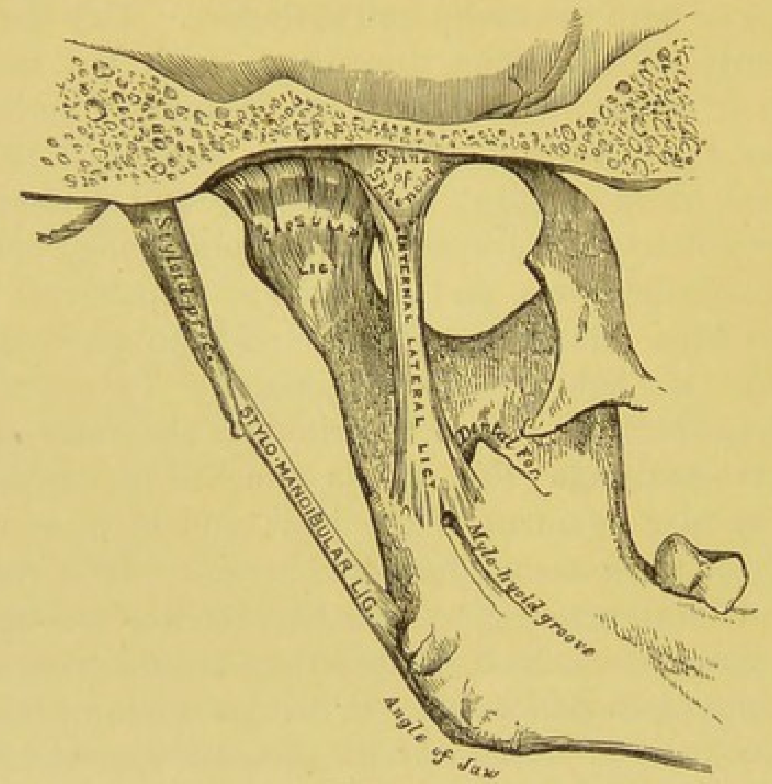

Fig. 37.

The **Pterygo-Mandibular** or **Pterygo-Maxillary Ligament,** the situation and attachments of which have already been indicated, is not usually described as one of the ligaments of the joint, although it most certainly becomes tense when the mouth is widely opened, and is quite as deserving of inclusion among the ligaments of the joint as the Stylo-Mandibular. It consists of a narrow band of tendinous fibres which extends from the hamular process of the internal pterygoid plate to the posterior part of the mylo-hyoid ridge of the mandible

The movements of the mandible are very complex, their complexity being due to the fact that the articulation is bilateral.

To the dental student an exact knowledge of the movements of the mandible, and a complete comprehension of the mechanism of their production, is essential. These will therefore be discussed in a separate chapter. As certain of the muscles of mastication are important factors in the determination of the direction and extent of those movements, it is convenient to describe the

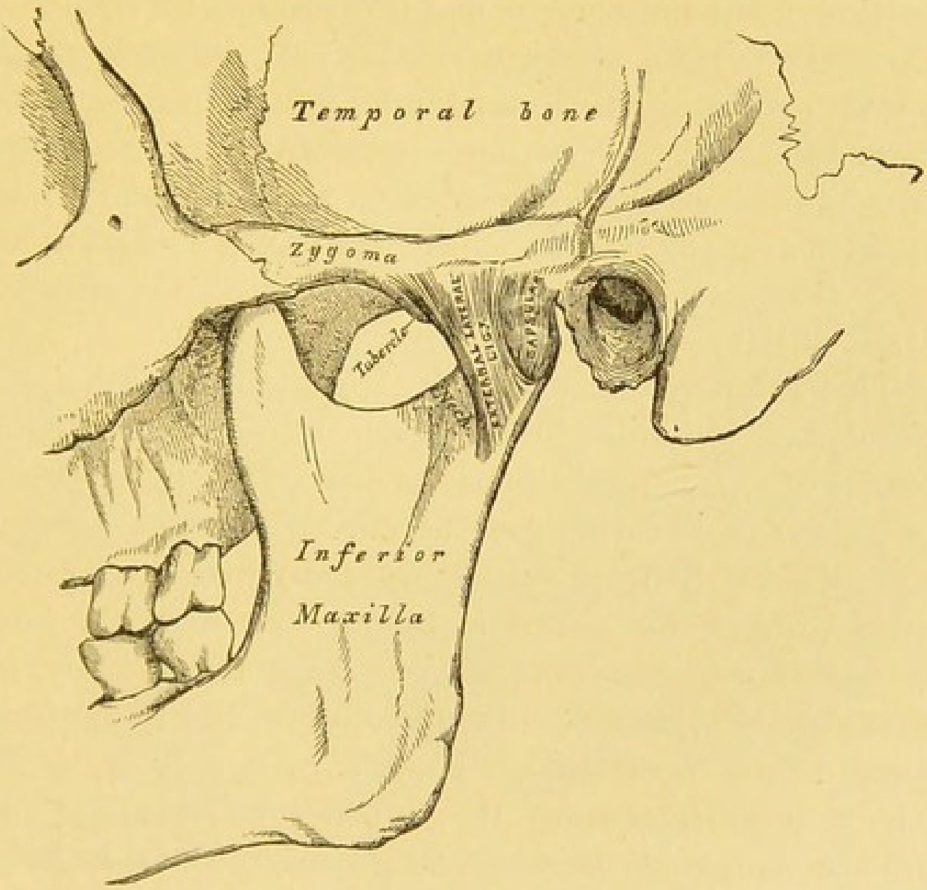

Fig. 38.

muscles directly concerned in the movements of the mandible, before passing to the description of the movements themselves.

Elevation of the Mandible is effected by three pairs of muscles, the *Masseter*, the *Temporal*, and the *Internal Pterygoid*.

The **Masseter** lies immediately beneath the integument and fascia of the face over the ramus of the mandible. It consists of two portions, a superficial and deep. The superficial *arises* from the malar process of the superior maxilla and from the anterior two-thirds of the lower border of the zygomatic arch. Its fibres pass downwards and backwards, to be *inserted* into the angle and lower half of the ramus of the mandible. This portion of the muscle acts as a protrusor of the mandible. The deep portion is much smaller. It *arises* from the posterior third of the lower border and the whole of the inner surface of the zygomatic arch, and its fibres, which pass almost vertically downwards, are *inserted* into the upper half of the ramus of the mandible, including the coronoid process. At its insertion it blends with the fibres of the superficial portion.

The **Temporal** muscle (*Fig.* 39) is fan-shaped, and is situated at the side of the head, occupying the entire extent of the temporal fossa. It *arises* from the whole of the temporal fossa, from the curved line on the frontal and parietal bones above, to the pterygoid ridge on the great wing of the sphenoid below, and from the inner surface of the temporal fascia. Its anterior fibres are nearly vertical, its middle fibres oblique, and its posterior fibres nearly horizontal. They converge to a tendon which is *inserted* into the inner surface, apex, and anterior border of the coronoid process of the mandible.

Both of these muscles (Masseter and Temporal) are comparatively superficial, and when caused to contract by firmly clenching the teeth, can be felt to move beneath the overlying integument. The student will remember that the anterior border of the masseter can be felt to move during contraction when the finger is placed in the mouth in contact with the anterior edge of the ramus of the jaw.

The **Internal Pterygoid** muscle (*Fig.* 40) *arises* from the pterygoid fossa of the sphenoid and the tuberosity of the palate bone. Its fibres pass downwards, outwards, and backwards, to be *inserted* into the lower and back part of the inner side of the ramus and angle of the mandible, as high as the dental foramen.

As the attachments of this muscle indicate, it is deeply situated, lying beneath the ramus of the mandible, which,

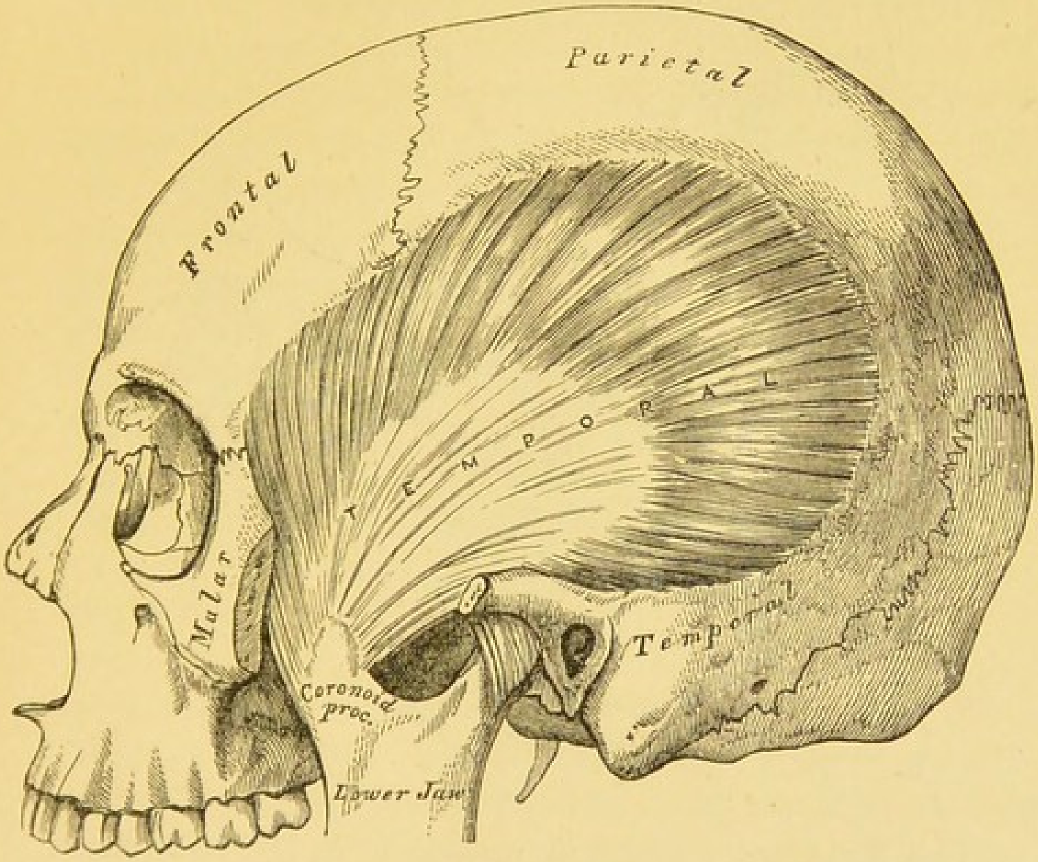

Fig. 39.

as shown in *Fig.* 40, has to be partly removed during dissection before the muscle is brought into view. By pressing the finger deeply underneath the angle of the mandible, in the living subject, and then pressing it outwards against the inner surface of the ramus, the contraction of this muscle can be felt when the teeth are clenched together.

These three muscles (Masseter, Temporal, and Internal Pterygoid) are supplied by the anterior division of the Inferior Maxillary nerve, by its Masseteric, Deep Temporal, and Pterygoid branches respectively.

Protrusion of the mandible is generally described as being effected by a pair of muscles, the *External Pterygoid*, acting simultaneously. The author's reasons for doubting this assumption will appear later.

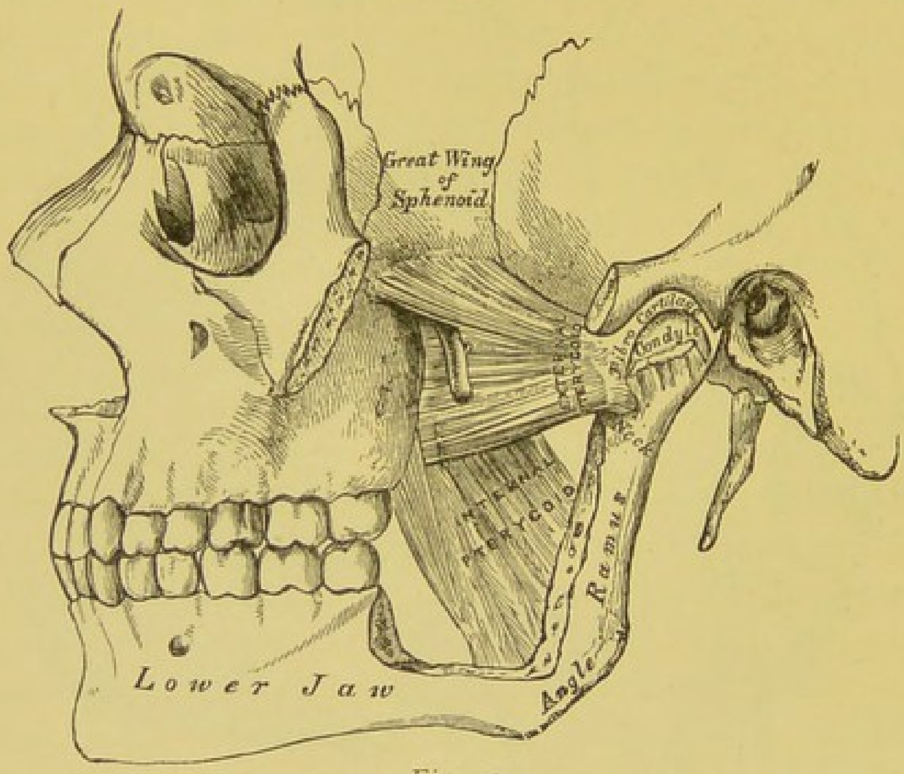

Fig. 40.

The **External Pterygoid** muscle (*Fig.* 40) is situated between the external pterygoid plate of the sphenoid, and the condyle of the mandible. It *arises* by two heads placed close together, the superior of which arises from the pterygoid ridge on the great wing of the sphenoid, and a portion of the bone included between it and the pterygoid process; and the inferior from the outer surface of the external pterygoid plate. From these attachments the muscle passes outwards and backwards, those fibres from the upper surface of origin passing slightly downwards, those from the lower surface of origin slightly upwards, converging to their *insertion* into the depression on the anterior part of the neck of the condyle of the mandible, and the corresponding part of the *inter-articular fibro-cartilage.*

This muscle is supplied by the anterior division of the Inferior Maxillary nerve, generally by a branch from the Buccal; but occasionally the anterior division gives off a separate nerve for it.

This muscle is a depressor of the jaw, although this action is not usually ascribed to it. It is also a protrusor. Besides these two actions it has an additional one hitherto undescribed; that is, acting with internal pterygoid and temporal of the same side, it can cause the whole mandible to move laterally, as distinguished from the lateral deflection of the body of the mandible which takes place during lateral protrusion. This movement is part of the rotatory movement of mastication, and in its production the action of the temporal is chiefly to prevent the external pterygoid protruding the mandible. With the internal pterygoid the temporal muscle also prevents the depression of the mandible; the resultant action of the simultaneous contraction of the three muscles being the **lateral movement** of the jaw in the direction of the pull of the pterygoid muscles; namely, inwards.

The muscles usually described as being directly concerned in **depression** of the mandible, are the *Digastric*, *Mylo-hyoid*, and *Genio-hyoid.* Some of the more fanciful anatomists add to these the *Platysma Myoides.* The author, for reasons that appear later, adds the *External Pterygoid.*

The **Digastric** muscle is situated immediately under, and a little upon the inner side of the body of the mandible, extending from the mastoid process of the temporal bone to the symphysis of the mandible. It consists of two fleshy bellies (hence its name), united by an intervening rounded tendon. The posterior belly, longer than the anterior, *arises* from the digastric groove of the mastoid process of the temporal bone, and passes downwards, forwards, and inwards, tapering gradually towards the hyoid bone,* where it becomes tendinous. This tendon perforates the fibres of the stylo-hyoid muscle, and is connected to the body of the hyoid bone by a broad band of aponeurotic fibres. The tendon then takes an upward turn and passes upwards, inwards, and forwards, and gives *origin* to the anterior belly of the muscle, which, continuing the direction of the tendon is *inserted* into a depression on the inner side of the lower border of the mandible close to the symphysis. Some of the fibres of the anterior belly do not arise from the central tendon of the muscle, but from the fascia which binds that tendon to the hyoid bone.

John Hunter, in discussing the action of the digastric muscle, wrote: "Let a finger be placed on the upper part of the Sterno-Mastoidœus muscle, just behind the posterior edge of the Mastoid Process, about its middle, touching that edge a little with the finger; then depress the Lower Jaw, and the posterior head of the Digastric will be felt to swell very considerably, and so as to point out the direction of the muscle. In this there can be no deception; for there is no other muscle in this part that has the same direction; and those who are of opinion that the Digastric does not depress the Lower Jaw will more readily allow this, when they are told that

* The student is recommended to refer to a text-book of general anatomy for the description of the hyoid bone, and the various muscles which are attached to it.

we find the same head of the muscle act in deglutition; but not with a force equal to that which it exerts in depressing the Lower Jaw."

The Digastric muscle is supplied by two nerves—its anterior belly by the Mylo-hyoid branch of the Inferior Dental nerve, and its posterior belly by the Facial nerve.

The **Mylo-hyoid** muscle is a flat triangular muscle situated immediately beneath the anterior belly of the Digastric, and forming with its fellow of the opposite side a muscle floor for the cavity of the mouth.

It *arises* from the mylo-hyoid ridge on the inner surface of the body of the mandible, extending from the last molar tooth to the symphysis. Its posterior fibres pass obliquely forwards, to be *inserted* into the body of the hyoid bone, while the greater number becoming gradually shorter as they are placed further forwards, meet at an angle with those of the opposite muscle, and end in a median tendinous raphé, extending from the symphysis of the mandible to the hyoid bone.

This muscle is supplied by the Mylo-hyoid branch of the Inferior Dental nerve.

The **Genio-hyoid** muscle is situated immediately underneath the median edge of the mylo-hyoid muscle. It *arises* from the inferior genial tubercle of the mandible, and passing downwards and backwards is *inserted* into the anterior surface of the body of the hyoid bone.

This muscle is supplied by the Hypoglossal nerve.

CHAPTER VIII.

THE MOVEMENTS OF THE MANDIBLE.

WHEN the mouth is shut so that the teeth come together in the manner described in the chapter on the occlusion of the teeth, the condyles of the mandible are normally as far back in the glenoid cavities as it is possible for them to go.

When the mouth is opened the movement of the mandible which takes place is **depression**, and movement in the opposite direction, as when the mouth is being closed, is termed **elevation.** If the fingers be placed over the situation of the condyles, *i.e.*, just in front of the tragus of the ear, when the mandible is depressed in the living subject the condyle is felt to move forwards, the forward motion of the condyle, and the downward motion of the body of the mandible being exactly synchronous. Similarly, during elevation of the mandible the condyle can be felt to return, the excursion of the condyle in normal cases ceasing at the moment of occlusion of the teeth. Obviously therefore the temporo-mandibular is not a simple hinge-joint, and although this fact has been recognized by anatomists since the days of John Hunter no explanation of the movements which are peculiar to the joint has been attempted in the text-books.

The first point worthy of notice in connection with the temporo-mandibular joint is that the structures forming it are not kept in the close apposition in which we find them by the ligaments of the joint. That these ligaments have little or no restraining power, except in preventing excessive movement, is obvious from the freedom of movement that they allow. Moreover, when ligaments resist the movement of a joint there is always great pain.

This apposition then, is maintained by the *tonic contraction* of the muscles that elevate the mandible and exercise a suspensory action upon it. The "dropping of the jaw" at the moment of dissolution is evidence of this suspensory action, for death destroys the tonicity of the

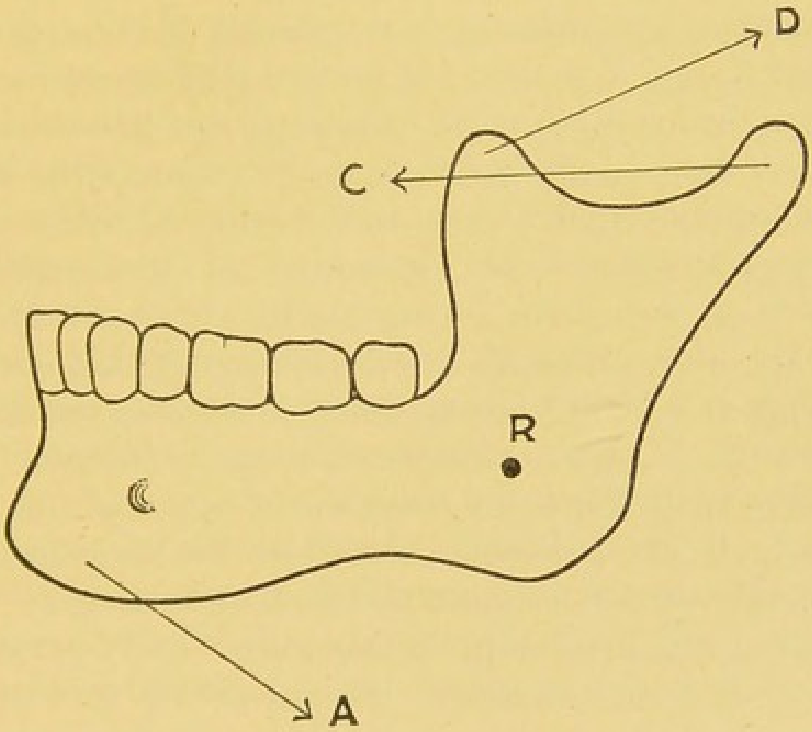

Fig. 41.

muscles. The first point then to be remembered is that the resistance to the forces that normally cause depression of the mandible is muscular. At this point we shall be considerably aided by a diagram of the mandible; and for the sake of simplicity it will be well to consider the action of the muscles separately.

The letter R in the diagram (*Fig.* 41) marks the effective point of attachment of the *masseter* and *internal* *pterygoid* muscles. This forms the primary point of resistance.

The arrow A marks the direction of the force exercised by the *depressor* muscles attached to the body of the mandible. This force, it is easily seen, would tend to rotate the mandible around R, a tendency to rotation much increased by the force exercised by the *external pterygoid* muscles, the direction of which is marked by the arrow C.

It is thus seen that the tendency produced by the force of the depressor muscles is to rotation of the mandible around R, and if it were not for the restraining force of the passive resistance of the *posterior fibres* of the *temporal* muscle, which acts in the direction of the arrow D, the condyle would travel to the articular eminence at the commencement of depression of the mandible, friction in the joint, owing to the presence of the *inter-articular cartilage*, which acts somewhat on the principle of a 'ball-bearing,' being practically negligible. Movement of the mandible during depression and elevation is therefore the resultant of opposed muscular forces.* If the resistance offered by the masseter and pterygoid muscles were not elastic, that is to say, if they did not yield gradually to the pull of the depressor muscles, it would of course be impossible to open the

* Some anatomists argue that depression of the mandible is effected by its unaided weight. If the student will place his finger on the digastric as directed by John Hunter (*see p.* 84), he will find that contraction of that muscle always occurs during depression of the mandible. Moreover, it is quite problematical, whether it is possible to voluntarily inhibit the action of the elevator muscles to the extent that would allow the weight of the jaw, which their tonicity usually counter-balances, to take effect. It is certainly impossible to do so when dislocation of the mandible occurs.

mouth. This the dentist often has experience of in cases of impacted wisdom teeth. R is therefore not a fixed point, and actual rotation of the mandible around it is also resisted by the parts of the temporal bone which help to form the articulation. Depression of the mandible then is the resultant of the forces exercised by the depressor muscles against the tonic resistance of the elevator muscles, slightly modified by the disposition of the fixed bony parts of the articulation.

It is obvious therefore from the disposition of these forces that a hinge movement in the condyle during depression of the mandible is impossible, and the movement of the condyle is therefore a **sliding** one.

According to John Hunter the inter-articular fibro-cartilage does not accompany the condyle through the full extent of its movement. He wrote—" it is to be observed, that in these glidings of the condyles forwards and backwards, the movable cartilages do not accompany the condyles in the whole extent of their motion ; but only so far as to adapt their surfaces to the different inequalities of the temporal bone ; for as these cartilages are hollow on their lower surfaces where they receive the condyle, and on their opposite upper surfaces are convex where they lie in the cavity ; but forwards, at the root of the eminence, that upper surface is a little hollowed ; if they accompanied the condyles through the whole extent of their motion, the eminences would be applied to the eminences, the cavities would not be filled up, and the whole articulation would be rendered very insecure."

During **elevation** of the mandible the condyle is prevented from returning prematurely to the glenoid cavity by the tonic resistance of the *external pterygoid* muscle ; and in normal cases, as before stated, it only completes its backward excursion at the moment that the teeth occlude.*

If the foregoing description of the mechanism of the production of the movement of depression be correct, it is obvious that the *external pterygoid* muscles acting alone would depress the jaw, and in the author's opinion there is no doubt that during mastication these muscles take an active part in the production of that movement. In proof of this, if the thumb be placed under the chin when the mouth is closed and the jaw depressed against its resistance, it will be found that there is a tendency to protrusion. This could not possibly occur if the *external pterygoid* muscles took no part in the production of the movement of depression, as all the other depressor muscles tend to retract the jaw.

To summarize, then, **depression** of the mandible is brought about by the simultaneous action of the *external pterygoid*, the *digastric*, the *mylo-hyoid*, and the *genio-hyoid* muscles ; and **elevation** is effected by the simultaneous action of the *masseter*, *internal pterygoid* and *temporal* muscles. During the movement of **depression** the condyle *slides forward*—during **elevation** it *slides backwards.*

The mandible can also be protruded. During **protrusion** the body of the mandible is carried forward, so that the lower incisor teeth occupy a position anterior to that of the upper incisor teeth. In this forward movement every part of the mandible participates, the condyles sliding forward on to the articular eminences.

* Under certain abnormal conditions the condyle completes its backward excursion before the teeth occlude; with results that have been indicated by the author in a paper upon the *Ætiology of Superior Protrusion* (Transactions of the Odontological Society, New Series, Vol. XXXIII, No. 2), read before the Odontological Society of Great Britain.

This movement is produced by the action of the *external pterygoid* and *masseter* and *internal pterygoid* muscles. In some text-books of anatomy the external pterygoid muscles are described as the only protrusors of the mandible; but the student who has understood the foregoing description of the mechanism of the production of depression of the mandible would expect those muscles acting alone to produce depression as well as protrusion. That this is the case he can easily prove for himself by forcibly protruding the jaw, when he will find that the *masseter* and *internal pterygoid* muscles are also brought into action.

The exact mechanism is the following. At the very commencement of the movement the *external pterygoid* muscles act alone. This draws forward the condyle, and at the same time depresses the mandible sufficiently to disengage the interlocking of the upper and lower teeth. The further the condyle is brought forward by the *external pterygoid* muscles the greater becomes the tendency to depression of the mandible; and to counteract this, the counterbalancing action of the masseter and *internal pterygoid* muscles becomes more marked, until when the jaw is protruded to the utmost, their contraction is so forcible as to be almost painful.

Retraction of the mandible is effected mainly by the action of the *temporal* muscles, aided by the elasticity of the *depressor* muscles. Although the temporal muscle is usually described as an elevator of the jaw, its chief function is as a retractor. To illustrate this, place the thumbs over the rami of the mandible so that the contraction of the masseter muscles can be felt by them, and the other fingers over the site of the temporal muscles. Then when the mouth is shut, and the teeth in the normal position of occlusion, clench the teeth firmly. Both the temporal and masseter muscles will be felt to contract. Now protrude the jaw and clench the teeth while it is protruded, and the masseter muscles alone will be felt to contract.

Protrusion may take place independently upon either side of the mandible. This is termed **lateral protrusion,** right or left, according to the condyle which is advanced. When this takes place the condyle on the side opposite to that protruded does not move backwards or forwards, but is shifted slightly outwards, this being brought about by the inward pull of the *external pterygoid* muscle of the *opposite side.* The effect of lateral protrusion upon the body of the mandible is to deflect it to the side opposite to that on which the protrusion occurs.

Alternating lateral protrusion with the lateral movement described in speaking of the action of the external pterygoid muscle results in a movement termed **rotation.**

During mastication all the movements above described occur, and if the student has thoroughly comprehended their mechanism he is in a position to understand the description of the physiological act of mastication. Such description, however, is beyond the province of this treatise. (*See* Appendix.)

CHAPTER IX.

THE TONGUE, SOFT PALATE AND TONSILS.

THE TONGUE plays such an important part in mastication and articulation that it is very necessary that the dental student should know the disposition and action of the muscles of which it is composed. It is, moreover, the sole muscular counterpoise to the forces which act upon the dental arches externally, and it is therefore obvious that its importance as a factor in determining the shape of the dental arches can scarcely be over-estimated.

The **tonsils** have for a long time been considered to be the chief factors in the production of certain dental malformations.

Occasionally it falls to the lot of the dentist to have to remedy defects of the **palate**. Moreover, the soft palate plays its part in the physiology of articulation, in which the teeth are such important factors. It is convenient, therefore, for the dental surgeon that a treatise on the anatomy of the teeth should include some account of these various organs and structures, all of which have a more or less direct bearing upon his daily work.

The **Tongue** is a slipper-shaped organ consisting of voluntary muscular fibres covered externally with mucous membrane. Its *apex*, which corresponds to the toe of the slipper, is freely movable, but when at rest lies in contact with the lingual surfaces of the crowns of the lower incisor teeth. Its *dorsum* or upper surface, when the mouth is shut, lies in contact with the hard and soft palates. This is a noteworthy fact, for it follows that, when shut, the mouth is merely a potential and not an actual cavity; and the importance of the tongue in determining the shape of the alveolar arches, and the disposition of the teeth, can be better understood if it be kept in mind how completely it fills the so-called *oral cavity* when the upper and lower teeth are in normal contact.

The *under* surface of the tongue is that part which lies in contact with the inner surface of the lower alveolar ridge. The mucous membrane covering the under surface of the tongue is less tightly adherent to it than that which covers the dorsum, and, as pointed out in a previous chapter, differs from it considerably in appearance. The muscles of which the tongue is composed, although not usually classed as muscles of mastication, play an important part in the performance of that function. The **septum** of the tongue is placed centrally, dividing the tongue into lateral halves; it is composed of fibrous tissue with some fat at the deeper portions. It is seen in transverse vertical sections to increase in width from above downwards.

The muscles of the tongue are extrinsic and intrinsic.

The extrinsic muscles are the *genio-hyoglossus*, *hyo-glossus*, *stylo-glossus*, *palato-glossus* and the *pharangeo-glossus*. *Five* pairs in all. The intrinsic muscles are the *superficial lingualis*—one muscle, *transverse lingualis*—a pair, and the *inferior lingualis*—a pair. *Five* muscles in all.

The blood-vessels of the tongue are the *lingual* vessels, and their branches. The branches of the lingual artery are the *hyoid*, *dorsalis linguæ*, *sublingual*, and *ranine*—making with the lingual trunk *five* in all.

The nerves are the *gustatory*, *glosso-pharyngeal*, *hypoglossal*, *chorda tympani* and *sympathetic*. *Five* pairs in all.

The fixed points of the tongue are the *genial tubercles* and *hyoid* bone.

The **Genio-hyoglossus** is a fan-shaped muscle with its apex *attached* to the superior genial tubercle of the

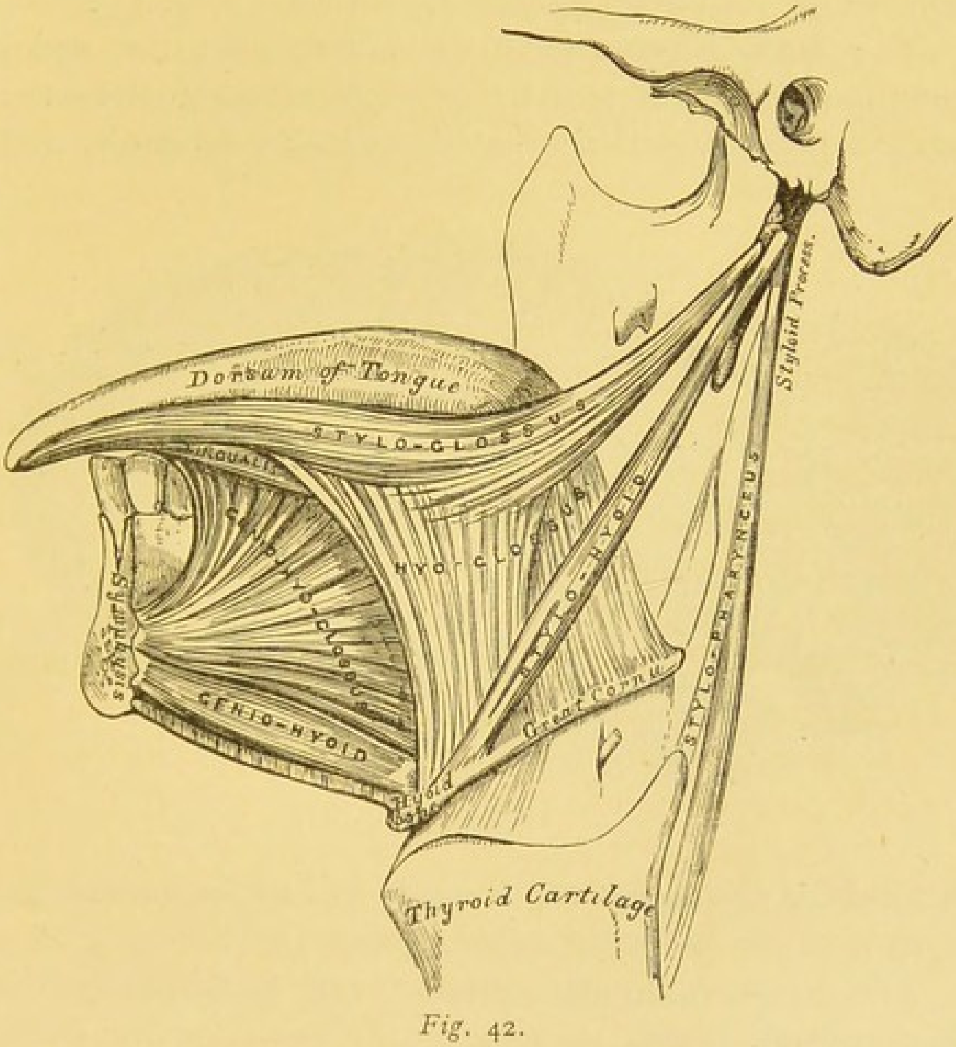

Fig. 42.

mandible, from which point it spreads out to be *inserted* into the body of the hyoid bone, the side of the pharynx, and the whole length of the tongue from the root to the apex (*Fig.* 42).

The **Hyo-glossus** (*Fig.* 42) is a flat quadrate muscle described as consisting of three parts—(1) Basio-glossus from the lateral surface of the hyoid bone ; (2) Kerato-glossus from the great cornu of the hyoid bone ; (3) Chondro-glossus from the small cornu of the same. From these three *origins* the fibres of the muscle pass upwards between the stylo-glossus and the inferior lingualis, and *blend* with the muscular structure of the tongue on its lateral and dorsal surfaces (*Fig.* 43).

The **Stylo-glossus** (*Fig.* 42) *arises* from the stylo-maxillary ligament and its point of attachment to the styloid process, and passing downwards, forwards, and

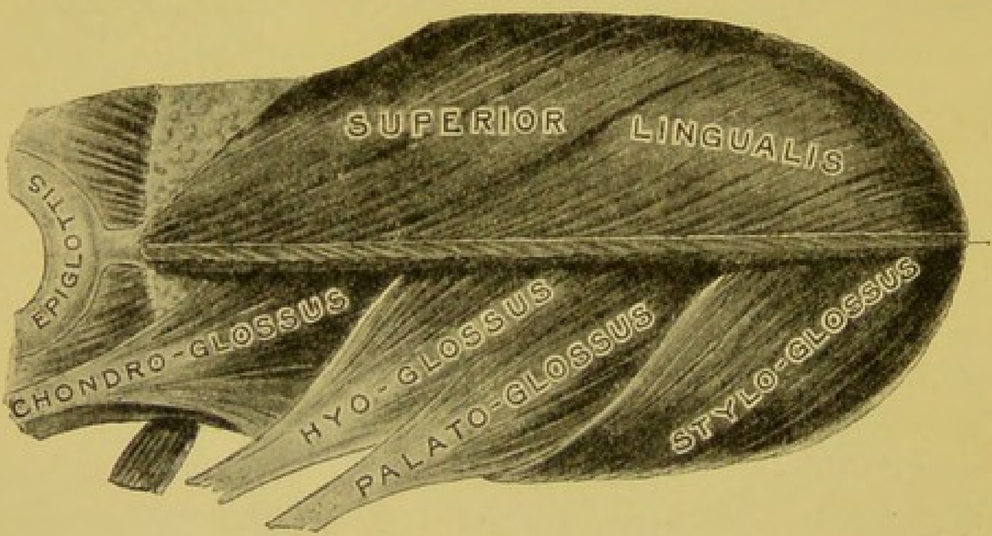

Fig. 43.

inwards, is *inserted* along the side and under part of the tongue as far as the tip (*Fig.* 43).

The three foregoing muscles are supplied by the hypo-glossal nerve.

The **Palato-glossus** (*Fig.* 45) occupies the anterior pillar of the fauces. It *arises* from the middle line of the soft palate where it blends with its fellow of the opposite side, and is *inserted* into the dorsal and lateral aspect of the tongue (*Fig.* 43). This muscle is supplied by the pharyngeal plexus.

The **Pharyngeo-glossus** is a small slip consisting of a few fibres of the superior constrictor of the pharynx (*Fig.* 45) which *arise* from the side of the tongue.

Of the intrinsic muscles of the tongue the uppermost as its name implies, is the **superficial** or **superior, lingualis** (*Fig.* 43). It consists of longitudinal fibres, *arising* from the base and running to the apex of the tongue, just beneath the dorsal mucous membrane, and is regarded as a single muscle because the septum of the tongue is indistinct above. The individual fibres do

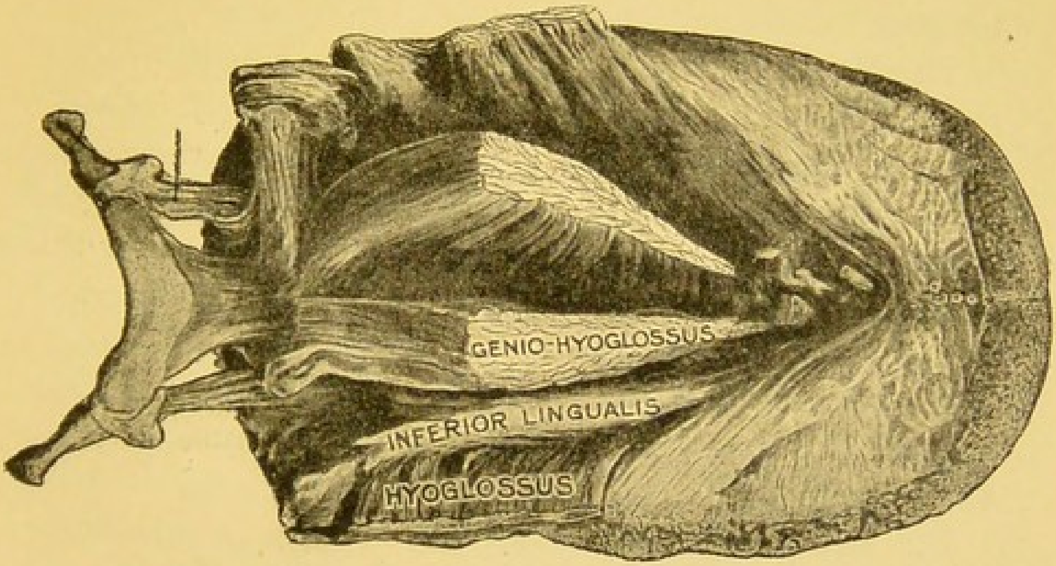

Fig. 44.

not run the whole length, but are *attached* at intervals to the sub-mucous and glandular tissues.

The **inferior lingual** muscles are rounded muscular bands passing along the under surface of the tongue from base to apex, between the genio-hyoglossus and hyo-glossus muscles (*Fig.* 44).

The **transverse lingual** muscles *arise* on each side from the septum, and passing transversely outwards they reach the dorsum and borders of the tongue. They are much interwoven with the other muscular fibres.

These muscles are supplied by the hypo-glossal nerve.

Actions.—The intrinsic muscles of the tongue are exclusively concerned in effecting variations of its shape.

The **Genio-hyoglossus** as a whole *depresses* the tongue, while its hinder part *protrudes* it, and its anterior fibres are said to *retract* it. It is, however, questionable whether they do more than recurve the tip of the tongue when protruded over the lower incisor teeth. Its most important function is its action as a protrusor of the tongue.

The **Hyo-glossus** *retracts* the tongue when protruded. Quain states that this muscle renders the tongue convex; Cantlie, on the contrary, asserts that it depresses the centre of the dorsum rendering it concave, and the disposition of the fibres of the muscle as they enter the substance of the tongue, is certainly in favour of the view expressed by the latter.

The **Stylo-glossus** muscle *retracts* the tongue and *elevates* its base. Acting separately each muscle tends to draw the tongue to its own side.

The **Palato-glossus** is important chiefly as a constrictor of the fauces. It also tenses the soft palate and *elevates* the tongue.

THE SOFT PALATE consists of mucous membrane, sub-mucous tissue, and a layer of muscles with blood-vessels and nerves. It is a prolongation backwards of the hard palate, and its oral aspect has been already described (*Chap. V*). It has two surfaces, an *oral* (usually described as inferior or anterior), and a *pharyngeal* (usually described as superior or posterior). Both are covered with mucous membrane overlying sub-mucous tissue with glands, which make up the main mass of the soft palate. The mucous membrane of the oral surface is continuous with that covering the hard palate, and is similar in character.

The muscles of the soft palate are :—(1) The *Palato-glossus* ; (2) The *Palato-pharyngeus* ; (3) The *Azygos uvulæ* ; (4) The *Levator palati*, and (5) The *Tensor palati*.

The **Palato-glossus** has already been described.

The **Palato-pharyngeus** (*Fig.* 45) occupies the posterior pillar of the fauces. It *arises* from the soft palate by two processes, a pharyngeal (usually described as posterior or superior), and an oral (usually described as anterior or inferior. The *pharyngeal* consists of scattered fibres which are continuous in the middle line of the palate with those of the opposite muscle.

The *oral*, which is much stronger, partly meets its fellow, and partly takes origin from the aponeurosis of the palate. The oral and pharyngeal processes are separated by the levator palati and azygos uvulæ muscles. From these origins the fibres pass downwards and backwards to be *inserted* into the back part of the pharynx, some of the fibres decussating across the middle line, and into the posterior border of the thyroid cartilage.

Its nerve supply is probably from the pharyngeal plexus.

A few fibres of this muscle which pass to the cartilage of the Eustachian tube are sometimes described as a separate muscle, the **Salpingo-pharyngeus**.

Actions.—This muscle *elevates* the pharynx and larynx, makes the soft palate tense, and narrows the fauces, and at the same time the posterior border of the soft palate is approximated to the posterior wall of the pharynx.

The **Azygos uvulæ** (*Fig.* 45) consists of two slips which *arise* one on each side, from the tendinous structure of the soft palate, and from the posterior nasal spine. They descend into the uvula.

Action.—It *raises* the uvula and shortens the soft palate.

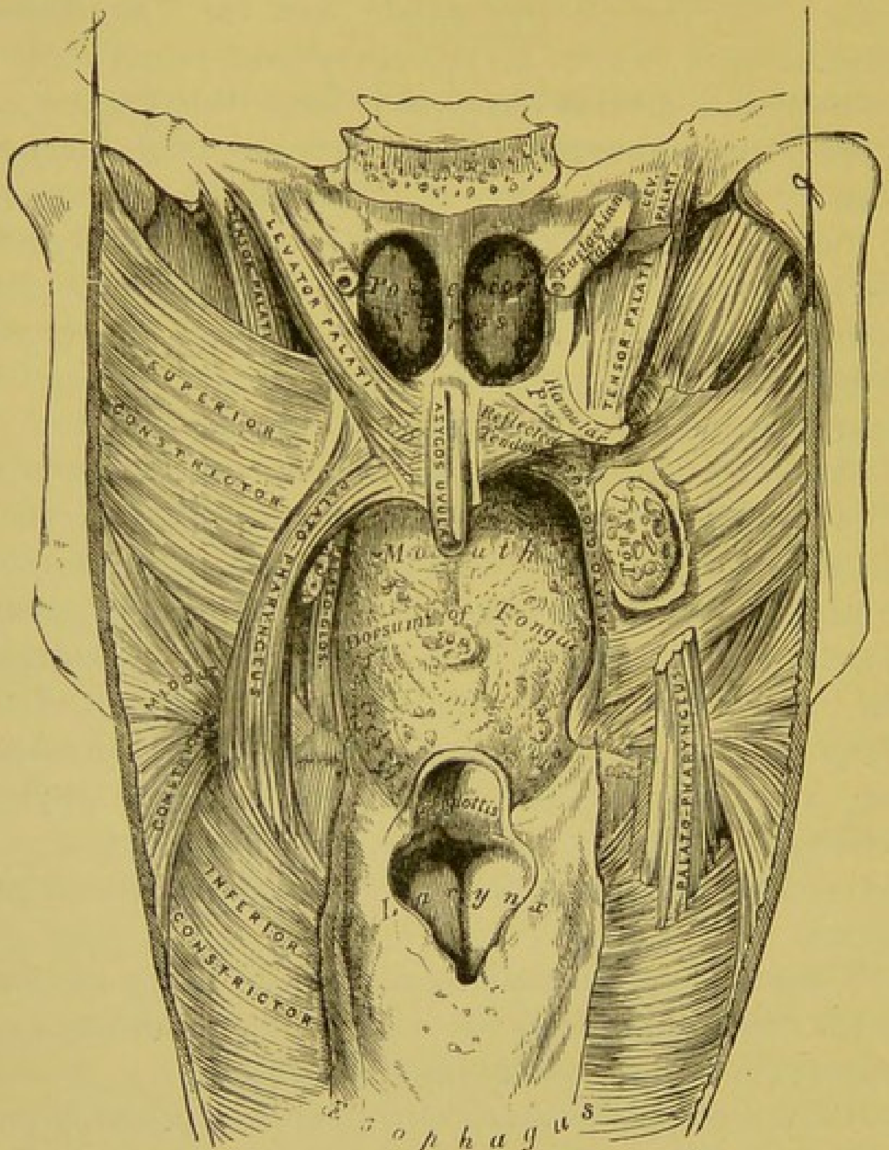

Fig. 45

It is probably supplied by the facial nerve through the petrosal branch of the Vidian.

The **Levator palati** (*Fig.* 45) *arises* from the rough quadrilateral surface on the inferior aspect of the petrous portion of the temporal bone, and from the cartilage of the Eustachian tube at its inner part. From these origins it forms a thick rounded muscle, which passes downwards and inwards above the upper border of the superior constrictor, becomes flattened, and is *inserted* into the aponeurosis of the soft palate, and its fellow of the other side under cover of the azygos uvulæ. It separates the oral and pharyngeal portions of the palato-pharyngeus.

It is supplied by the facial nerve through the petrosal branch of the Vidian

Action.—It draws the soft palate *upwards* and *backwards*, shutting off the pharynx from the posterior nares.

The **Tensor palati** or **Circumflexus** (*Fig.* 45) *arises* from the scaphoid fossa at the root of the internal pterygoid plate of the sphenoid bone, from the spine of the sphenoid, the vaginal process of the temporal and the outer side of the Eustachian tube. The fibres converge to a tendon which turns round the hamular process (a synovial sheath intervening), and is *inserted* into a transverse ridge near the posterior border of the horizontal process of the palate bone on its under aspect.

It is supplied by a nerve from the otic ganglion.

Action.—This muscle fixes and tenses the soft palate, and is regarded by most anatomists as the means by which the Eustachian tube is opened during deglutition.

The blood-vessels supplying the palate are the ascending palatine, the descending palatine and the ascending pharyngeal.

THE TONSILS are important to the dental student mainly from the fact that they are supposed, when abnormally large, to be the cause of certain malformations of the dental arches.

They are two prominent bodies which lie between the anterior and posterior pillars of the fauces. Each tonsil lies upon the superior constrictor muscle of the pharynx, and is in immediate relation with the internal carotid artery. Externally, in relation to the surface of the neck, the tonsil corresponds to the angle of the mandible, and, when enlarged, may be felt by the finger in that situation. It consists chiefly of lymphoid tissue, and its inner surface which projects into the fauces presents from twelve to fifteen flask-like depressions which are easily visible to the naked eye.

The arteries supplying it are branches of the ascending pharyngeal, the ascending and descending palatine, the tonsillitic and the dorsalis linguæ. The nerve supplying it is the glosso-pharyngeal which forms a circle around it —the *circulus tonsillaris.*

Chapter X.

THE SALIVARY GLANDS.

IN connection with the mandible three pairs of glands are met with, having for their function the secretion of saliva. They are the **Parotid,** the **Submaxillary,** and the **Sublingual.** To the naked eye they appear, when cut into, to consist of nodules of yellow gland substance separated by a plentiful connective tissue, rich in blood-vessels.

The Parotid Gland (*Fig.* 46) is the largest of the three salivary glands. It lies on the side of the face, in front of the ear, and extends deeply into the space behind the ramus of the mandible. Its weight varies from five to eight drachms.

Its outer surface is convex and lobulated, and its anterior border, from which the duct (**Stenson's duct**—*ductus Stenonianus*) is given off, lies upon the masseter muscle.

The relations of the gland are of great importance. It is *bounded* in front by the ramus of the jaw and the masseter muscle; above by the zygoma and external auditory meatus; behind and above, by the mastoid process; behind and below, by the sterno-mastoid muscle, and, more deeply, by the posterior belly of the digastric muscle. It is separated from the submaxillary gland by the stylo-maxillary ligament, a process of the deep cervical fascia. *Over* the gland lie the superficial structures (the skin and fascia and the platysma myoides muscle) and the facial branches of the great auricular nerve. *In* the gland are found the facial nerve, the temporo-maxillary plexus of veins, and the external carotid artery breaking up into its terminal branches. *Beneath* the gland is the styloid process, on which the gland splits, part going forwards with the internal

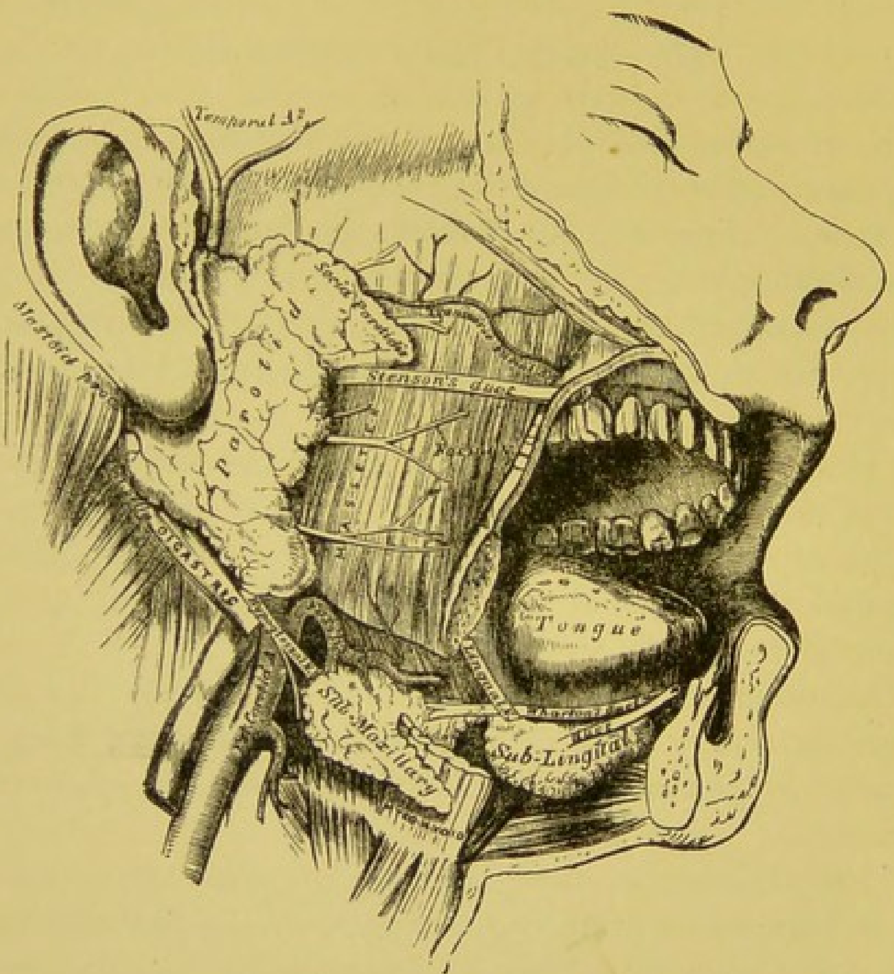

Fig. 46.

maxillary artery, and part backwards beneath the digastric muscle.

The parotid duct passes from the anterior border of the gland about a finger's breadth beneath the zygoma. It runs across the masseter muscle, and just beyond its anterior border pierces the buccinator muscle, and, passing for a short distance obliquely through the mucous membrane of the cheek, opens into the mouth by a well-marked orifice opposite the crown of the upper second molar tooth. The course of the duct may be found by taking a line from the lobule of the ear forwards to a point midway between the nose and mouth, and the posterior half will be found to correspond to the line of the duct.

The **Socia Parotidis** (*Fig.* 46) is a small separated portion of the gland lying upon the masseter muscle above the level of the duct.

There is a lymphatic gland and sometimes more than one in the substance of the parotid.

The *arteries* of the gland are derived directly from the external carotid.

The *nerves* are from the carotid plexus of the sympathetic, from the facial, the superficial temporal, and the great auricular.

THE SUBMAXILLARY GLAND (*Fig.* 46) weighs from two to two-and-a-half drachms, and is situated immediately below the body and inferior surface of the mandible, and above the digastric muscle. In company with its duct, it bends round the posterior free margin of the mylo-hyoid muscle. In the erect posture of the body (not the usual attitude, it must be remembered, of the dissecting room subject) the relations of the gland are as follows: Above, the mylo-hyoid, hyoglossus, and stylo-glossus muscles, and the facial artery; below, the cutaneous structures, including the platysma myoides muscle; externally, the mandible, which is grooved for its reception; internally, the anterior belly of the digastric muscle. It is separated from the parotid gland by the stylo-maxillary ligament.

The duct of the gland (**Wharton's duct**) is about two inches in length. It passes, with part of the glandular structure, round the posterior border of the mylo-hyoid muscle, and then runs forwards and inwards above that muscle and between it and the hyoglossus and genio-hyoglossus muscles, and beneath the sublingual gland, which it actually touches, to reach the frænum linguæ, where a papilla of some size marks the point of its opening into the mouth.

There are lymphatic glands in the substance of the submaxillary. It receives its blood supply from the facial and lingual vessels.

It is supplied through the submaxillary ganglion by the chorda tympani nerve. It also receives filaments from the mylo-hyoid and the sympathetic nerves.

THE SUBLINGUAL GLAND (*Fig.* 46) weighs scarcely one drachm. It is situated along the floor of the mouth, just beneath the mucous membrane, in which it forms the ridges described in Chapter V. The lobules of this gland are not so closely united as those of the parotid and submaxillary, and the duct from many of them opens directly into the mouth along the ridge which indicates the position of the gland. These, with others which open into the duct of Wharton, are termed the **ducts of Rivini**, or *Rivinian ducts*, and are about a dozen in number. One duct, longer than the rest, (which is occasionally derived in part from the submaxillary gland) runs along Wharton's duct, with which it has a common opening; this has been termed the **duct of Bartholin.**

The *relations* of the gland are: Above, the mucous membrane of the mouth; below, the mylo-hyoid muscle, the submaxillary gland, Wharton's duct, and the gustatory nerve; internally, the genio-hyoglossus muscle; and, externally, the mandible.

The vessels to the gland are the submaxillary and submental branches of the facial.

The nerve is the gustatory.

CHAPTER XI.

THE MUSCLES OF THE LIPS AND MOUTH.

THE muscles of the lips and cheeks are of interest to the dental surgeon chiefly on account of their mechanical influence upon the teeth. The etiology of the more common oral malformations has never yet been clearly elucidated, chiefly because the writers upon the subject do not appear to have given careful consideration to the various conditions and forces that determine the normal development of the alveolar ridges, and maintain the equilibrium that we find in well-formed jaws of the adult. To remark that pathology should be founded upon physiology savours of platitude, but it is unlikely that anyone who is familiar with the dental literature of this country will urge that the suggestion is superfluous.

The student of dental physiology should be able to find in the text-books of dental anatomy some account of the various structures to which reference is frequently necessary, and for this reason a brief description of the muscles of the lips and cheeks finds a place herein.

Around the external surface of the mouth is situated an orbicular muscle, the orbicularis oris; and this is joined by other muscles which converge towards the aperture, viz.: the levator labii superioris alæque nasi, the levator labii superioris proprius, the levator anguli oris, the zygomatici, the risorius, the buccinator, the depressor anguli oris, the depressor labii inferioris, the levator labii inferioris, and the platysma myoides.

The **Orbicularis Oris**, or *sphincter oris*, forms the greater part of the substance of the upper and lower lips, and consists of two portions—a labial or marginal, which

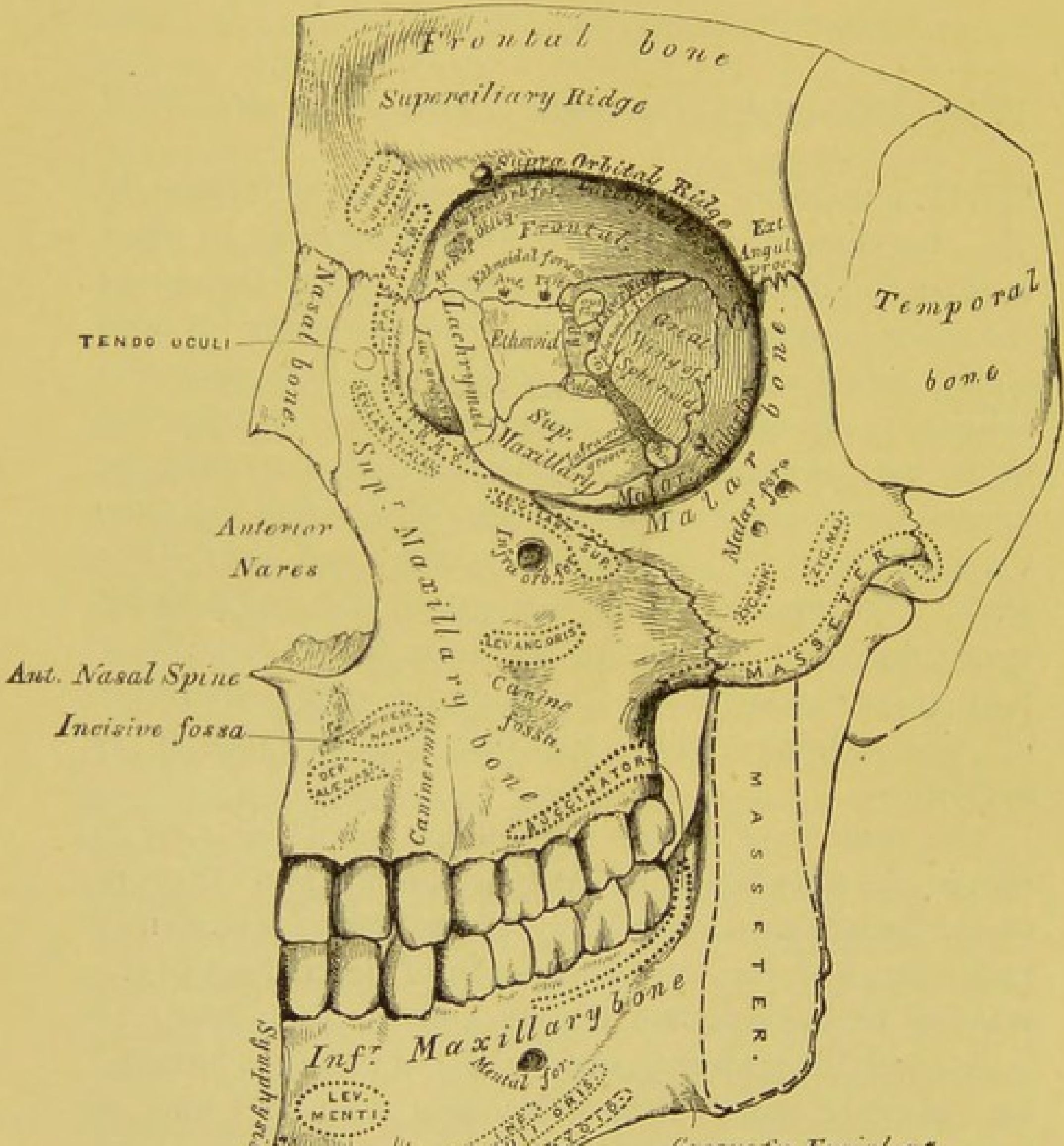

Fig. 47.

is simply a thick rounded sphincter muscle surrounding the mouth, occupying the red part of the lips, and passing from lip to lip unconnected with bone; and an outer or facial part which *arises* from the superior maxilla by two slips, one on each side of the anterior nasal spine, the other from the incisive fossa ; also from the lower jaw by one slip on each side from the ridge formed by the canine tooth. The fibres from the upper jaw pass downwards and outwards, and those from the lower jaw upwards and outwards to the angle of the mouth, where they blend with the other muscles.

Action.—The whole muscle acting, the lips are pressed together, and the mouth tightly closed. The inner fibres turn inwards the red margin and close the mouth. The outer fibres draw the lips to the bone and evert their free edges.

The **Levator Labii Superioris Alæque Nasi** *arises* from the upper part of the nasal process of the superior maxilla (*Fig.* 47). Descending along the side of the nose it divides into two parts, one of which is *inserted* into the wing of the nose, and the other, which is the larger, into the upper lip, where it blends with the other muscles.

Action.—It raises the upper lip, and raises and dilates the nostril.

The **Levator Labii Superioris Proprius** *arises* from the superior maxilla and malar bones at the margin of the orbit above the infra-orbital foramen (*Fig.* 47), and is *inserted* into the upper lip, blending with the other muscles.

Action.—Raises the upper lip.

The **Levator Anguli Oris** *arises* from the canine fossa beneath the infra-orbital foramen (*Fig.* 47), and is *inserted* in the angle of the mouth.

Action.—Elevates the corner of the mouth.

The **Zygomatici** are two narrow bundles of muscular fibres extending obliquely from the most prominent part of the cheek to the angle of the mouth. They are termed major and minor.

The **Zygomaticus Major** *arises* from the outer surface of the malar bone near the zygomatic suture (*Fig.* 47), and is *inserted* into the angle of the mouth, blending with the orbicularis oris.

Action.—Draws the angle of the mouth upwards and backwards.

The **Zygomaticus Minor** *arises* from the anterior inferior part of the malar bone (*Fig.* 47), and joins the outer border of the levator labii superioris proprius.

Action.—Assists in elevating the upper lip.

The **Risorius**, or smiling muscle, is by some regarded as a part of the platysma myoides. Some separate fibres however, *arise* from the fascia over the masseter muscle, and are *inserted*, together with those which appear part of the platysma myoides, into the angle of the mouth.

The **Buccinator** is a muscle partly of expression and partly of mastication. It consists of a thin and flat but strong set of muscular fibres in contact with the mucous membrane, and forming a considerable part of the fleshy wall of the mouth. It *arises* from the outer surface of the alveolar process opposite the molar teeth in each jaw (*Fig.* 47), and posteriorly from the pterygo-maxillary ligament, a band of fibrous tissue extending from the tip of the hamular process of the internal pterygoid plate of the sphenoid bone to the back part of the mylo-hyoid ridge of the mandible. The central fibres converge and decussate, passing to opposite lips ; the marginal fibres pass to the lips without decussating, the whole blending with the orbicularis at the angle of the mouth. This muscle is perforated by Stenson's duct.

Action.—When one muscle acts, the corner of the mouth is drawn outwards. When both act together, the mouth is widened transversely. Its most important action, however, is as a muscle of mastication, for by its contraction it helps to bring the food between the teeth, and prevents it from collecting in the sulcus of the cheek.

The **Depressor Anguli Oris**, or *triangularis menti*, *arises* from the external oblique line of the mandible (*Fig.* 47), and is inserted into the angle of the mouth.

Action.—Draws down the angle of the mouth.

The **Depressor Labii Inferioris**, or *quadratus menti*, *arises* from a depression on the lower jaw, extending from near the symphysis to a point beyond the mental foramen (*Fig.* 47), and is *inserted* into the lower lip.

Action.—It depresses and everts the lower lip.

The **Levator Labii Inferioris**, or *levator menti*, *arises* from the incisor fossa (*Fig.* 47) and is *inserted* into the integument of the chin.

Action.—It dimples and pulls up the integument of the chin, and by so doing raises the lower lip.

The **Platysma Myoides** is a skin muscle, placed between two layers of cervical fascia. It *arises* from the fascia covering the acromion process of the scapula and the pectoralis major, deltoid, and trapezius muscles. *Insertion.*—The fibres pass upwards and inwards; the most anterior cross beneath the skin, the right being the more superficial; the next are inserted into the margin of the mandible from the symphysis to the angle (*Fig.* 47), and the most posterior are prolonged over the jaw and the masseter muscle into the angle of the mouth.

Action.—When the jaw is tightly closed it raises the skin over the front of the chest, at the same time drawing the angle of the mouth outwards and downwards.

All the muscles described in this chapter are supplied by the facial nerve, but the platysma myoides is supplied by the superficial cervical nerve also, and the buccinator by the buccal branch of the inferior maxillary.

Chapter XII.

THE VASCULAR RELATIONS OF THE TEETH AND CONTIGUOUS PARTS.

THE blood supply of the teeth, both of the upper and lower set, is derived entirely from certain branches of the internal maxillary artery.

The Internal Maxillary Artery (*Fig.* 48) is the larger of the terminal branches of the external carotid artery from which it arises opposite the neck of the condyle of the mandible. At its origin it is concealed by the parotid gland, whence it curves horizontally forwards between the mandible and the internal lateral ligament of the temporo-mandibular articulation, then passes obliquely forwards and upwards upon the external pterygoid muscle, and, opposite the interval between the two heads of that muscle, passes inwards to the spheno-maxillary fossa, where it ends by breaking up into a number of branches.

It is divided into three stages by its relation to the external pterygoid muscle. The first extends from its origin to the lower border of the external pterygoid muscle; the second is whilst the artery is in contact with the muscle; and the third after it has passed between the two heads of the muscle.

The *first* stage has the ramus of the mandible external to it; the internal pterygoid muscle internal to it, with the gustatory nerve, the inferior dental nerve, and the internal lateral ligament intervening.

Its branches are, (*a*) the deep auricular, (*b*) the tympanic, (*c*) the middle meningeal, (*d*) the inferior dental.

(*a*) The **deep auricular** enters and supplies the external auditory meatus.

(*b*) The **tympanic** passes through to the Glaserian fissure to supply the tympanum.

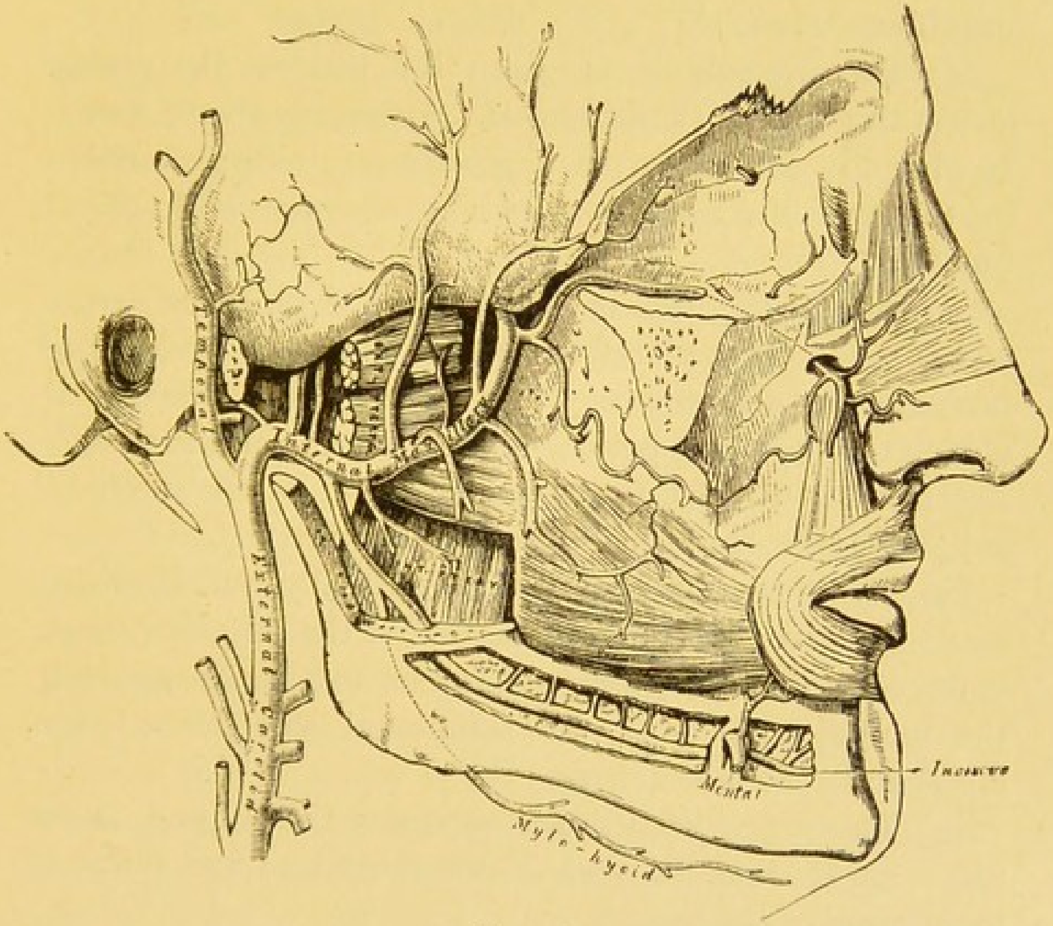

Fig. 48.

(*c*) The **middle meningeal** passes between the roots of the auriculo-temporal nerve, and enters the cranium through the foramen spinosum of the sphenoid bone, after giving off the small meningeal artery which enters the skull by the foramen ovale, both of these arteries supplying the dura mater.

8

(*d*) The **inferior dental** artery descends on the internal lateral ligament of the mandible, and enters the inferior dental foramen to run forwards in the inferior dental canal to anastomose with its fellow at the symphysis of the mandible.

Its branches are (1) the mylo-hyoid, (2) the dental and nutrient, (3) the mental, and (4) a small un-named branch, which sometimes comes off from the internal maxillary trunk.

(1) The *mylo-hyoid* is given off just as the artery enters the inferior dental canal. It runs with the nerve bearing the same name in a groove on the inner surface of the mandible, aud ramifies upon the mylo-hyoid muscle.

(2) Within the inferior dental canal the inferior dental artery gives off *nutrient* vessels to the bone, and *dental* branches to the teeth. The latter enter the dental alveoli to supply the peridental membrane, minute vessels also passing through the apical foramina of the teeth to supply the dental pulps. (*See frontispiece.*)

(3) The *mental* artery, which is usually but unnecessarily described as the continuation of the inferior dental, emerges through the mental foramen to anastomose with the mental branch of the submental and the inferior labial and coronary arteries.

(4) This small branch accompanies the lingual nerve for a short distance, and is distributed to the mucous membrane of the mouth.

The *second* stage of the internal maxillary artery passes either wholly beneath the external pterygoid muscle, or lies superficial to the lower half of the muscle, and dips down between its two heads. Its branches are (*a*) deep temporal, (*b*) pterygoid, (*c*) masseteric, and (*d*) buccal.

(*a*) The **deep temporal** branches are two in number, anterior and posterior. They ascend beneath the temporal muscle, which they supply.

(*b*) The **pterygoid** branches are several small offshoots which pass both outwards and inwards to supply the pterygoid muscles.

(*c*) The **masseteric** is a small but regular branch which accompanies a nerve of the same name over the sigmoid notch to supply the masseter muscle.

(*d*) The **buccal** branch runs forward upon the buccinator muscle with the buccal nerve, and is distributed to the muscles and mucous membranes of the cheek.

The *third* stage of the artery commences after it has passed between the two heads of the external pterygoid muscle; it enters the pterygo-maxillary fossa through the pterygo-maxillary fissure. Its branches are, (*a*) the posterior dental or alveolar, (*b*) the infra-orbital, (*c*) the descending or superior palatine, (*d*) the Vidian, (*e*) the pterygo-palatine, (*f*) the spheno-palatine.

(*a*) The **posterior dental** artery breaks into branches which enter the posterior dental canals of the superior maxilla, and supply the bone and the upper molar and premolar teeth and the dental periosteum enclosing their roots, in the same way that the dental branches of the inferior dental artery supply the lower teeth. Other branches supply the lining membrane of the antrum and the soft tissues covering the upper alveolar ridge. One special branch does not enter the canals, but runs forward to the face upon the zygomatic ridge of the superior maxilla to anastomose with the infra-orbital artery.

(*b*) The **infra-orbital** artery runs forward in the infra-orbital groove and canal, emerging upon the face through the infra-orbital foramen. While in the groove it sends small branches to some of the ocular muscles and the lachrymal sac. From the canal it sends down an *anterior dental* branch, which descends in a canal of the same name to supply the bone, the incisor and canine teeth, the mucous membrane of the antrum and lower part of the nose. In the face the infra-orbital artery terminates in *palpebral*, *nasal*, and *labial* branches, which supply the regions indicated by their names.

(*c*) The **descending** or **superior palatine** artery descends through the posterior palatine canal with the large palatine nerve, and emerges from its lower end at the back of the hard palate. Running forward in the groove between the alveolar and palate processes of the superior maxilla, it supplies the soft tissues over the hard palate and inner surface of the superior alveolar ridge, and the bone of the palate, also the tonsil and soft palate. In front it terminates in a small artery that ascends through the anterior palatine foramen to the septum of the nose.

(*d*) The **Vidian** artery passes through the Vidian canal with the nerve of the same name to reach the Eustachian tube and pharynx.

(*e*) The **pterygo-palatine** artery passes through a canal of the same name to reach the Eustachian tube and pharynx.

(*f*) The **spheno-palatine** artery enters the spheno-palatine foramen and breaks up into branches. It supplies the mucous membrane of the superior meatus of the nose, the ethmoidal, frontal and sphenoidal sinuses, and the antrum ; whilst one long branch, the artery of the septum, or *naso-palatine*, descends along the side of the septum in a groove in the vomer, until it reaches the anterior palatine foramen, where it communicates with the vessel ascending from the roof of the mouth (the terminal branch of the superior or descending palatine artery.)

The blood supplied by the internal maxillary artery is for the most part returned by the **internal maxillary vein,** which is a short vessel, often double, formed from the **pterygoid plexus** of veins. The pterygoid plexus is a close network of veins, covering both surfaces of the external pterygoid muscle, and extending also over the inner surface of the external pterygoid. It receives three or four *deep temporal* veins from the temporal muscle, and branches from the *pterygoid* and *masseter.* The *posterior dental* or *alveolar*, and a large vein, the *inferior dental*, from the inferior dental canal of the mandible, also join the plexus. Two *middle meningeal* veins return blood to the plexus from the structures supplied by the middle meningeal artery; and lastly, *superior palatine*, *infra-orbital*, and *spheno-palatine* veins, as well as a communicating branch from the inferior ophthalmic vein, also enter the plexus. The blood is conveyed from the plexus by the **internal maxillary** vein or veins, and the **deep facial** veins.

LYMPHATIC SYSTEM.—The lymphatic glands, situated in and upon the parotid gland, drain the temporal region, and their efferent vessels pass to the submaxillary and superficial cervical glands.

The **submaxillary lymphatic glands** (*Fig.* 49) are situated in the submaxillary region, and some of them are embedded in the substance of the salivary gland. Besides receiving lymph from the parotid glands, they receive the superficial lymphatics of the face and forehead, also lymphatics from the submaxillary and sublingual salivary glands, from the floor of the mouth, and from the front of the tongue. A small group of these glands which lies between the anterior bellies of the digastric muscles, is sometimes distinguished as the **supra-hyoid.**

The deep lymphatics of the orbit, nose, temporal and zygomatic fossæ, palate, buccal region, and upper part of the pharynx, drain into the **internal maxillary** lymphatic glands, which are situated upon the side of the

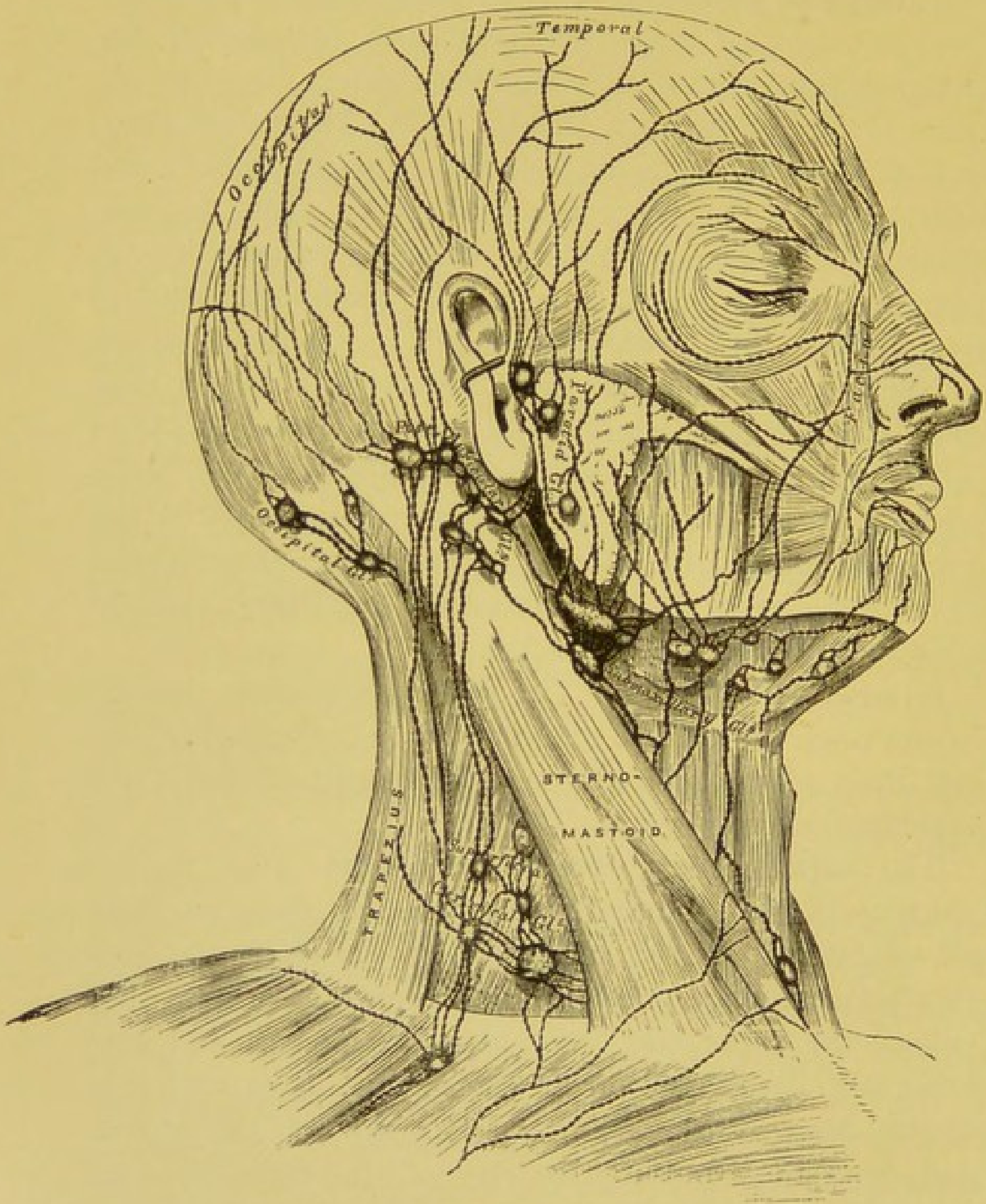

Fig. 49.

pharynx beneath the parotid gland and the ramus of the mandible.

All the groups already mentioned ultimately drain into the **superficial** and **deep cervical** glands.

The **superficial cervical** (*Fig.* 49) glands, about six in number, accompany the external jugular vein.

The **deep cervical** glands are arranged for the most part along the internal jugular vein. They consist of two groups—a superior and an inferior; those above the thyroid gland being included in the superior, those below it in the inferior group.

CHAPTER XIII.

THE FIFTH CRANIAL NERVE.

DISEASES and lesions of the dental tissues are so common, and so frequently associated with severe pain, that it behoves the dental student to acquire as exact a knowledge as possible of the nerves which supply the teeth, and he is strongly advised to particularly note their connection with the sympathetic nervous system. Pain which arises from inflammation of a dental pulp is so frequently referred by the sufferer to regions remote from its source, that no treatise upon the teeth can be considered complete which does not include a comprehensive account of the nerves which supply them, and the collateral branches and connections of these nerves. It is convenient, too, for the dental practitioner, should he at any time find reference necessary.

The **fifth cranial, tri-geminal,** or **tri-facial** nerve has two roots. They arise in the floor of the fourth ventricle of the cerebrum ; the **motor** root from the upper part of the ventricle, near the middle line under cover of the nucleus for the seventh ; the **sensory** root arises from the superior sensory nucleus at the upper and outer part of the floor of the fourth ventricle, under cover of the *substantia ferruginea*, seen on the surface as an iron-grey mass—the *locus cæruleus.* Both roots receive accessory bands ; the motor receives the *descending* root of the fifth from the grey matter around the aqueduct of Sylvius ; the sensory the *ascending* root of the fifth, in close connection with the upper end of the tubercle of Rolando and the nucleus of the auditory nerve. The group of cells from which the ascending root arises is named the *inferior sensory nucleus* of the fifth. The nerve roots *emerge* from the *pons varolii*, midway between the upper and lower borders, and half way along its lateral aspect.

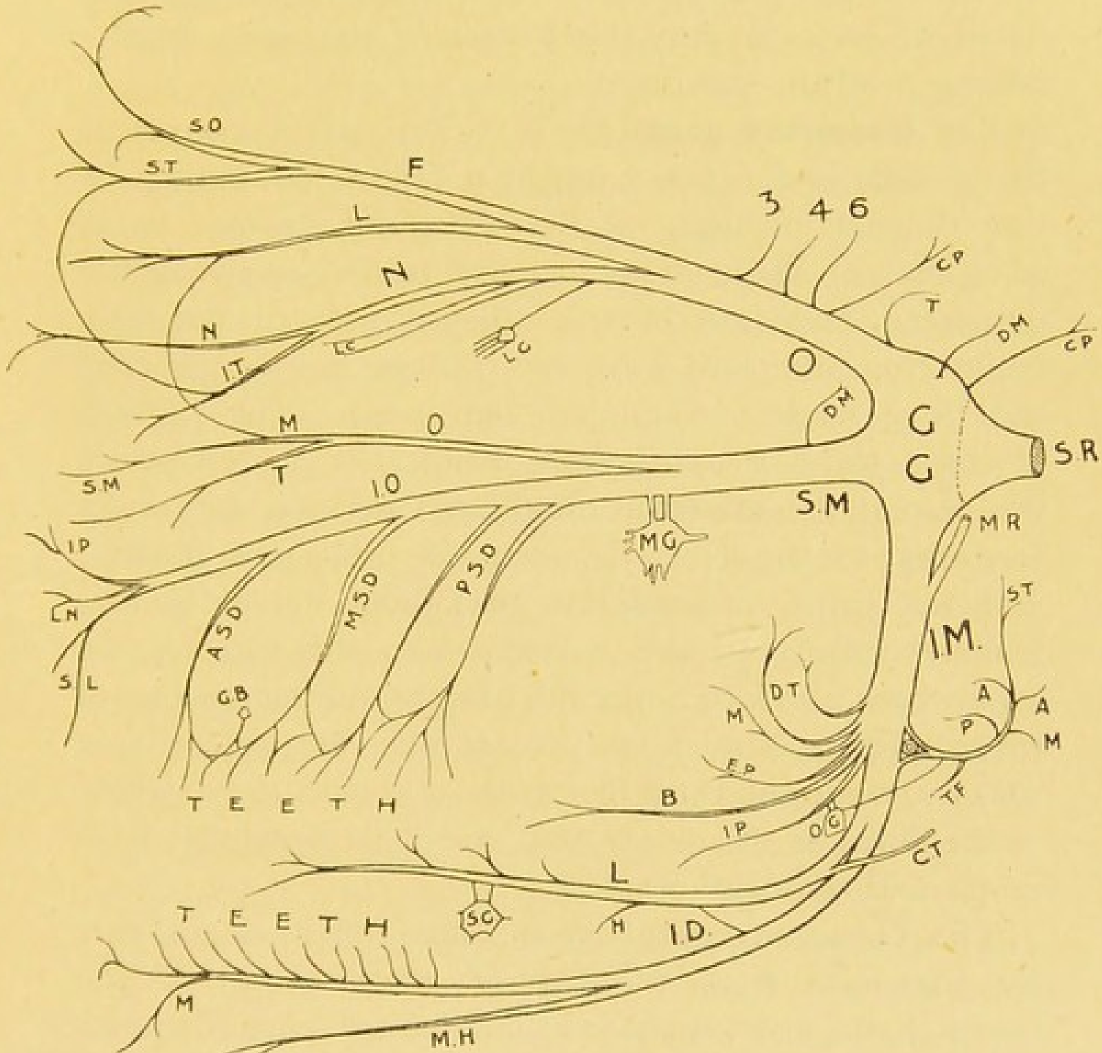

Fig. 50.—Diagram of the Fifth Cranial Nerve.

The motor root is smaller than the sensory, and emerges above it, being separated from it by a few transverse fibres of the pons. The two roots turn together over the upper aspect of the tip of the petrous portion of the temporal bone, under cover of the tentorium cerebelli and the superior petrosal sinus. The fibres of the sensory root spread out to enter the **Gasserian ganglion**. The smaller root inclines downwards on the inner side of the larger root, and passes outwards *beneath* the ganglion (without its fibres being in any way incorporated with it), and then emerges from the cranium through the *foramen ovale* to join the lowest of the three trunks issuing from the ganglion.

The **Gasserian ganglion** (G.G., *Fig.* 50) is a mass of nerve cells and fibres lying in a hollow on the tip of the petrous portion of the temporal bone. It is semilunar in shape, the concavity behind receiving the outspread filaments of the sensory root of the fifth, while from its fore part or convex border proceed the three large divisions of the nerve. The highest of these (first or **ophthalmic** trunk) enters the orbit; the second, the **superior maxillary** nerve, is continued forwards to the face, between the orbit and mouth; and the third, the **inferior maxillary** nerve, is distributed chiefly to the external ear, the tongue, the lower teeth, the face below the mouth, and the muscles of mastication. The first two trunks are exclusively sensory, while the third has associated with it the whole of the fibres of the motor root, and thus distributes both motor and sensory branches.

The Gasserian ganglion is joined on its inner side by filaments from the *carotid plexus* (C.P.) of the sympathetic, and furnishes from its back part filaments to the dura mater (D.M.)

The **Ophthalmic** (O.) or first division of the fifth nerve is the smallest of the three offshoots from the Gasserian ganglion. It is directed upwards, inwards, and forwards from the inner end of the ganglion, along the outer wall of the cavernous sinus in company with the third and fourth nerves, and divides into three terminal branches, two of which, the *frontal* (F.) and *lachrymal* (L.), enter the sphenoidal fissure above the two heads of the external rectus muscle; whilst the third, the *nasal* branch (N.), passes through the fissure between the two heads of the external rectus, and between the upper and lower divisions of the third nerve.

The ophthalmic nerve before its division is joined by filaments from the cavernous plexus of the sympathetic (C.P.) and gives off a small recurrent branch to the tentorium (T.), and communicating branches to the third, fourth, and sixth nerves (3, 4, 6).

The **frontal** is the largest of the three branches. It enters the orbit above the external rectus, and between the lachrymal and fourth nerves, and runs forwards above the levator palpebræ muscle. About the middle of the orbit, or rather more anteriorly, it divides into two branches, *supratrochlear* and *supra-orbital.*

The *supratrochlear* (S.T.) passes onwards, and above the pulley of the superior oblique muscle ascends to the frontal region over the internal angular process of the frontal bone. It drops down branches to the conjunctiva and the skin of the upper eyelid, and gives a communicating branch to the infratrochlear branch of the nasal nerve (*see Diagram*). It is distributed to the integument of the lower and middle part of the forehead.

The *supra-orbital* nerve (S.O.) passes through the supra-orbital foramen to the forehead, beneath the orbicularis palpebrarum muscle. It divides into outer (larger) and inner branches which perforate the occipito-frontalis muscle, and supply the skin of the fore and upper parts of the scalp as far backwards as the lambdoid suture of the cranium. Small branches also pass to the pericranium, and, as the nerve emerges from the orbit, it drops down branches to the eyelid and conjunctiva. The branches of the supra-orbital nerve form communications with the adjacent ramifications of the facial nerve, as indeed do all the cutaneous offshoots of the fifth.

The **lachrymal** nerve enters the orbit by the sphenoidal fissure, lying above the external rectus muscle. It is external to the frontal nerve, and enclosed in a separate sheath of dura mater. It runs forwards along the upper edge of the external rectus muscle, to be distributed chiefly to the lachrymal gland. A few filaments are continued onwards through the palpebral ligament to supply the eyelid, conjunctiva, and the skin over the external angular process of the frontal bone. Near the lachrymal gland the nerve has a communicating filament with the orbital branch of the superior maxillary (*see Diagram*).

The **nasal** nerve enters the orbit between the two heads of the external rectus muscle, crosses to the inside of the optic nerve, and divides into two filaments, the *internal* or *nasal* (N.), and the *infratrochlear* (I.T.). Before dividing it gives off a branch to the ophthalmic or *lenticular ganglion* (L.G.), forming its long or sensory root; also two *long ciliary* nerves (L.C.) which join some of the inner short ciliary nerves.

The *internal* or *nasal* branch of the nasal nerve enters the anterior ethmoidal foramen, runs along the cribriform plate of the ethmoid, and passing through the nasal slit by the side of the crista galli, enters the nose. It here grooves the back of the nasal bones, sends a few twigs to the nose, and finally emerging between the bone and the cartilage, supplies the skin of the nose from the root to the tip.

The *infratrochlear* branch of the nasal nerve emerges beneath the superior oblique muscle, and ends in filaments which supply the conjunctiva, the caruncle, the lachrymal sac, and the integument of the eyelids and root of the nose. It gives a branch of communication to the supratrochlear nerve (a terminal branch of the frontal).

The **superior maxillary** nerve (S.M.), or second division of the fifth, passes through the foramen rotundum, crosses the spheno-maxillary fossa, traverses the infra-orbital groove and canal, and emerges from the infra-orbital foramen, to be distributed on the cheek. The nerve is wholly sensory, but Meckel's ganglion, with which it is associated, receives motor filaments from the facial nerve.

Near its origin it gives off a small recurrent branch to the dura mater and middle meningeal artery. In the spheno-maxillary fossa it gives off :—

(1) An **orbital** branch (O.), which enters the orbit by the spheno-maxillary fissure, then runs along the outer wall of the orbit, where it receives a communicating branch from the lachrymal, and divides into malar and temporal branches.

The *malar* branch passes through the malar canal of the malar bone, and, as the *subcutaneous malæ*, supplies the skin over the malar region.

The *temporal* branch passes through the temporal canal in the malar bone to the temporal fossa, then runs upwards between the temporal muscle and the malar bone, and becomes cutaneous a finger's breadth above the zygoma, and supplies the skin over the fore part of the temporal region.

(2) Two short **branches to Meckel's ganglion,** which lies immediately below the nerve.

(3) The **postero-superior dental** nerves (P.S.D.), two in number, pass downwards and forwards to enter the zygomatic surface of the superior maxilla. They send filaments to the soft tissues covering the external surface of the superior alveolar ridge, and the adjacent mucous membrane of the cheek, and then enter the posterior

dental canals, to communicate with the middle and antero-superior dental nerves, terminating in offshoots to the molar and premolar teeth and the lining membrane of the antrum.

(4) In the infra-orbital groove and canal, the superior maxillary nerve, now sometimes termed **infra-orbital**, (I.O.), gives down a branch, the **middle superior dental** (M.S.D.), which runs in the outer wall of the antrum, and communicates with the postero-superior dental in the premolar region.

(5) More anteriorly, near the infra-orbital foramen, the **antero-superior dental** nerve is given off. It descends in the anterior wall of the antrum to the incisor and canine teeth. A small nasal branch is given off from it which supplies the pituitary membrane in the fore part of the floor of the inferior meatus and the adjoining part of the nasal fossa.

The anterior, middle and posterior dental nerves, while still contained in their bony canal, communicate freely with one another to form a plexus (**superior dental plexus**) from which branches to the teeth are given off. In the canine region connected with the plexus is a small ganglion, the *ganglion of Bochdalek* (G.B.). The terminal dental filaments from the superior dental nerves pass into the alveoli containing the roots of the upper teeth to supply the dental periosteum, and pass through the apical foramina of the roots of the upper teeth to supply the tooth pulps.

In the face.—The superior maxillary nerve appears in the face half an inch below the centre of the margin of the bony orbit. At its point of exit from the infra-orbital foramen, the levator labii superioris proprius muscle lies above and covers the nerve; below it is the levator anguli oris. The infra-orbital branch of the facial nerve forms a plexus—the **infra-orbital plexus**—with this nerve at its exit. From the plexus branches pass to the eyelid, nose, and upper lip by the *inferior palpebral*, *lateral nasal*, and *superior labial* branches respectively. These nerves after they emerge from the plexus contain both motor and sensory filaments, supplying the muscles and integument of the regions to which they are distributed.

The **Inferior Maxillary** nerve (I.M.) is the third and largest division of the fifth. It passes out through the foramen ovale as two roots, the larger being derived from the Gasserian ganglion, the other being the motor root of the fifth nerve (M.R.). These two join immediately they enter the zygomatic fossa, and the trunk so formed almost immediately separates into two sets of branches, anterior and posterior. The anterior, the smaller of the two, receives most of the fibres of the motor root.

The short trunk of the nerve as it issues from the oval foramen gives off a slender recurrent branch which passes through the foramen spinosum with the middle meningeal artery. It traverses the petro-squamous fissure of the temporal bone, and is distributed to the mucous lining of the mastoid cells.

The branches forming the *anterior* set are:—

(*a*) The *deep temporal* (D.T.)—two or three in number—pass directly outwards between the base of the skull and external pterygoid muscle, and hooking round the pterygoid ridge on the great wing of the sphenoid, ascend to the under aspect of the temporal muscle, which they supply.

(*b*) The *masseteric* nerve (M.) passes in company with the posterior deep temporal, and continuing its horizontal course, crosses the sigmoid notch of the mandible to enter the under surface of the masseter muscle. It also gives filaments to the temporo-mandibular articulation.

(*c*) The *external pterygoid* (E P.) enters the inner aspect of that muscle.

(*d*) The *buccal* branch (B.) penetrates between the two heads of the external pterygoid and reaches the buccal region, to supply the mucous membrane of the cheek as far forwards as the angle of the mouth.

(*e*) The *internal pterygoid* (I.P.) descends to the inner surface of the muscle of that name. It has developed upon it the *otic ganglion* (O.G.).

All the branches of this set are motor except the *buccal*, which is largely sensory.

The branches forming the *posterior* set are:

(*a*) The **auriculo-temporal** nerve passes backwards from the main trunk beneath the external pterygoid muscle, to the inner side of the neck of the mandible. It has two roots, between which the middle meningeal artery ascends to the foramen spinosum (*see Diagram*). Changing its direction, it passes outwards behind the capsule of the temporo-mandibular joint and in front of the parotid gland. Finally it turns upwards over the zygoma, and accompanying the temporal artery, divides into terminal branches to supply the skin of the temporal region. Its branches are: (1) *Communicating* with the otic ganglion and the temporo-facial division of the facial nerve (T.F.); (2) *Articular* (A.), to the temporo-mandibular joint; (3) To the *external auditory meatus* (M); (4) *Parotid* (P.), to the gland; (5) *Antero-auricular* (A.), to the fore part of the ear; (6) Its terminal (*superficial temporal*) branches (S.T.).

(*b*) The **lingual** or **gustatory** nerve (L.) appears from under cover of the external pterygoid muscle in front of the inferior dental nerve. It then passes downwards and forwards between the ramus of the mandible and the internal pterygoid muscle, and gradually inclining forwards, gains the side of the tongue. There the nerve lies upon the hyoglossus muscle, and above the deep part of the submaxillary gland. Finally it crosses Wharton's duct, hooks round below it, and gaining its inner side, ascends to the surface of the tongue. The chorda tympani nerve from the facial, joins the gustatory nerve about half an inch below its origin (C.T.). Besides its connection with the facial through the chorda tympani, the gustatory gives communicating branches to the submaxillary ganglion, the inferior dental, and the hypoglossal nerves. While on the side of the tongue the nerve gives branches to the mucous membrane of the inner aspect of the inferior alveolar ridge, and to the sublingual gland. Its most important branches, however, are those that perforate the muscular structure of the tongue to supply the fungiform and filiform papillæ of that organ.

(*c*) The **inferior dental** nerve (I.D.) descends at first beneath the external pterygoid, and then lies between the mandible and the internal lateral ligament, and behind the lingual nerve. Accompanied by the artery of the same name, it enters the inferior dental foramen, travelling forward in the inferior dental canal. Within the canal it gives off branches corresponding to those of the artery, the dental branches coming off from a fine plexus (**inferior dental**) formed by the nerve in the canal.

Just before entering the canal it gives off the *mylo-hyoid* branch (M.H.). This descends in a groove in the inner aspect of the mandible, and is conducted downwards between the bone and the internal pterygoid muscle to the submaxillary region, where it runs upon the mylo-hyoid muscle to the anterior belly of the digastric muscle. It supplies both these muscles. Its fibres can be traced backwards within the sheath of the inferior dental nerve to the motor root of the fifth.

The *mental* branch (M.) emerges from the canal by the mental foramen, and divides into branches which supply the integument of the chin and lower lip and the mucous membrane of the lower lip.

Connected with the fifth nerve are certain ganglia, viz.: the Gasserian, the ophthalmic or lenticular, Meckel's, the otic, the submaxillary, and the ganglion of Bochdalek.

The **Gasserian ganglion** has already been described.

The **ophthalmic** or **lenticular ganglion** is situated between the external rectus muscle and the optic nerve, below the line of the ophthalmic artery. It is pink in colour, about the size of a pin's head, and more or less quadrilateral in shape. It has entering at its postero-inferior angle a motor filament from the lower division of the third nerve; at its postero-superior angle a sensory filament from the nasal of the fifth, and at its posterior border, sympathetic filaments from the cavernous plexus around the internal carotid artery. Ten or twelve *short ciliary* branches are given off from the ganglion in an upper and lower bundle; these perforate the sclerotic coat of the eyeball around the optic nerve, and run forwards to supply the cornea and muscles of the iris.

Meckel's ganglion, the *spheno-palatine* or *nasal ganglion* is deeply placed in the spheno-maxillary fossa, below the level of the superior maxillary nerve, from which it derives its sensory roots—two in number. The motor and sympathetic roots are contained in the Vidian nerve, which enters the ganglion posteriorly. The ganglion is reddish grey in colour, triangular in form, and convex on its outer surface. Its diameter is about a fifth of an inch.

The *Vidian nerve* can be traced backwards from the ganglion through the Vidian foramen, and the cartilage which closes the middle lacerated foramen; it resolves itself into motor and sympathetic roots: (*a*) the motor is continued backwards beneath the Gasserian ganglion as the *great superficial petrosal* nerve, to the hiatus Fallopii ; a branch from the tympanic plexus of the glosso-pharyngeal, bestowing special sense, joins the nerve in the substance of the petrous portion of the temporal bone. (*b*) The sympathetic branch, the great deep petrosal, goes to join the carotid plexus.

The branches of *distribution* of Meckel's ganglion are:

(*a*) *Ascending* to the periosteum of the orbit and mucous membrane of the posterior ethmoidal and sphenoidal sinuses.

(*b*) *Descending* through the posterior palatine canals. This set exhibits three main branches:

(1) A large or *anterior palatine* to the roof of the mouth and inner aspect of the superior alveolar ridge; it joins the naso-palatine in front. When entering its canal, this palatine nerve gives off a nasal branch, which ramifies on the middle and lower spongy bones ; and, just before leaving the canal, another nasal branch to the membrane covering the lower spongy bones. These are the postero-inferior nasal branches.

(2) The small, or *posterior palatine*, supplies the tonsil, the soft palate and uvula, and the levator palati and azygos uvulæ muscles.

(3) The *external palatine* nerve, the smallest of the series, courses through the external palatine canal, between the maxilla and the tuberosity of the palate bone, to be distributed to the tonsil and soft palate.

(*c*) *Internal*, or *naso-palatine*, branches enter the superior meatus of the nose, where they are mostly distributed, by the naso-palatine foramen. One branch, however, the *naso-palatine* or *nerve of Cotunnius*, runs down the septum of the nose, between the periosteum and pituitary membrane, towards the anterior palatine canal. The nerves of opposite sides descend to the palate through the mesial subdivisions of the canal (the foramina of Scarpa) the nerve of the right side usually behind that of the left. In the lower common foramen, the two naso-palatine nerves are connected with each other in a firm plexus, and they end in several filaments, which are distributed to the mucous membrane of that part of the inner aspect of the superior alveolar ridge which lies behind the incisor teeth. They communicate with the great palatine nerve.

(*d*) A *posterior*, or *pharyngeal*, branch passes back through the pterygo-palatine foramen, to supply the mucous membrane around the Eustachian tube.

The **otic ganglion**, or *ganglion of Arnold*, is of greyish pink colour and of oval shape, measuring about one sixth of an inch in its longest (antero-posterior) diameter. It is situated upon the nerve to the internal pterygoid muscle, and lies on the inner aspect of the inferior maxillary division of the fifth immediately it emerges from the foramen ovale. Its relations are: above, foramen ovale; externally, inferior maxillary nerve; internally, tensor palati muscle; behind, the middle meningeal artery. The *motor* root is derived from the nerve to the internal pterygoid; the *sensory* root from the sensory trunk of the inferior maxillary; and its *sympathetic* from the nerves around the middle meningeal artery. Besides these roots, the ganglion receives at its posterior part the small superficial petrosal nerve, bringing to it motor branches from the facial, and branches of special sense from the glosso-pharyngeal. The auriculo-temporal has branches passing to and from its trunk to the otic ganglion. From the ganglion proceed two muscular branches, to the tensor tympani and the tensor palati, while the nerve to the internal pterygoid finds its way through the ganglion.

The **submaxillary ganglion** is intimately associated with the gustatory nerve. It lies upon the hyoglossus muscle with the gustatory nerve above it, and the deep part of the submaxillary gland and Wharton's duct below it. It is greyish pink in colour and triangular in shape, and is somewhat larger than the ophthalmic ganglion. It is connected by anterior and posterior filaments with the gustatory nerve, from which it thus appears to be suspended. It receives motor filaments from the chorda tympani, and sensory from the gustatory, both of which, however, seem to be dropped down from the gustatory nerve, owing to the chorda tympani being associated with the gustatory; the sympathetic root is from the *nervi mollis* on the facial artery.

The ganglion sends five or six branches to the submaxillary gland, and others run forward to the mucous membrane of the mouth and Wharton's duct. The anterior branch of communication with the gustatory is probably composed of filaments which pass from the ganglion, and are distributed with the offshoots of that nerve. Occasionally a small branch or two can be traced to the hypoglossal nerve.

The **ganglion of Bochdalek** seems nothing more than an enlargement due to the confluence of two or three of the filaments of the superior dental plexus.

Chapter XIV.

SECTIONAL ANATOMY OF THE TEETH.

IF a tooth be sawn completely through in the direction of its long axis, a central cavity will be exposed, in which will be found the remains of the soft tissue with which it was filled during the life of the tooth. If the tooth be recent, and from an injected specimen, this soft tissue will be found to completely fill the cavity, and to be extremely vascular. This vascular tissue constitutes the **dental pulp**, and the cavity it fills is the **pulp cavity**, which comprises the **pulp chamber**, and the **pulp canal** (or canals). (*See Plate II.*)

As it is part of the daily work of the dental surgeon to remove the contents of the pulp cavity, it is obviously of importance that its disposition and relative size should be accurately known.

Before passing to a detailed description of the pulp cavities of the various teeth, let us briefly consider the disposition of the hard tissues themselves. Referring to the longitudinal section of the tooth, the distinction between the enamel and the dentine is quite clear to the naked eye; the dentine being dead white in colour, and opaque, the enamel translucent, a well-marked line of demarcation between the two structures being clearly visible.

The **enamel** is seen to cap the whole of the crown of the tooth, being thickest over the cusps or cutting edges, as the case may be, thinning gradually away towards the neck, where, in the permanent teeth, it ends imperceptibly.

The remainder of the hard structure of the tooth appears homogeneous to the naked eye; indeed that incomparable observer, John Hunter, imagined it to be so, although he found it difficult to reconcile that view with certain pathological phenomena. His observations on the subject are of sufficient interest to be worthy of repetition. *

"That part of a tooth which is bony, is nearly of the same form as a complete tooth; and hence, when the enamel is removed, it has the same sort of edge, point, or points, as when the enamel remained. We cannot by injection prove that the bony part of a tooth is vascular, but from some circumstances it would appear that it is so, for the fangs of teeth are liable to swellings, seemingly of the spina ventosa kind, like other bones. . . . . The following considerations would seem to show that the teeth are not vascular: first, I never saw them injected in any preparation, nor could I ever succeed in any attempt to inject them, either in young or old subjects; and therefore believe that there must have been some fallacy in the cases where they have been said to be injected. Secondly, we are not able to trace any vessels going from the pulp into the substance of the new-formed tooth; and whatever part of a tooth is formed, it is always completely formed, which is not the case with other bones. But what is a more convincing proof, is reasoning from the analogy between them and other bones, when the animal has been fed with madder. Take a young animal, viz., a pig, and feed it with madder for three or four weeks; then kill the animal, and upon examination you will find the following

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* *The Natural History of the Human Teeth.—Part II, p.* 36.

appearance: first, if this animal had some parts of its teeth formed before the feeding with madder, those parts will be known by their remaining of this natural colour; but such parts of the teeth as were formed while the animal was taking the madder will be found to be of a red colour. This shows that it is only those parts that were forming while the animal was taking the madder that are dyed; for what were already formed will not be found in the least tinged. This is different in all other bones, for we know that any part of a bone which is already formed, is capable of being dyed with madder, though not so fast as the part that is forming; therefore, as we know that all other bones when formed are vascular, and are thence susceptible of the dye, we may readily suppose that the teeth are not vascular, because they are not susceptible of it after being once formed. But we shall carry this still farther; if you feed a pig with madder for some time, and then leave it off for a considerable time before you kill the animal, you will find the above appearances still subsisting, with this addition, that all the parts of the teeth which were formed after leaving off feeding with the madder will be white. Here then in some teeth we shall have white, then red, and then white again; and so we shall have the red and the white colour alternately through the whole tooth.

"This experiment shows, that the tooth once tinged, does not lose its colour; now as all other bones that have been once tinged lose their colour in time, when the animal leaves off feeding with madder (though very slowly), and as that dye must be taken into the constitution by the absorbents, it would seem that the teeth are without absorbents, as well as other vessels.

"This shows that the growth of the teeth is very different from that of other bones. Bones begin at a point, and shoot out at their surface; and the part that seems already formed, is not in reality so, for it is formed every day by having new matter thrown into it, till the whole substance is complete; and even then it is constantly changing its matter.

"Another circumstance in which teeth seem to differ from bone, and a strong circumstance in support of their having no circulation in them, is that they never change by age, and seem never to undergo any alteration, when completely formed, but by abrasion; they do not grow softer like other bones, as we find in some cases, where the whole earthy matter of the bones has been taken into the constitution."

By the foregoing it is obvious that John Hunter, without the aid of the microscope, clearly distinguished **dentine** from bone; and from his observation upon "the swellings seemingly of the spina ventosa kind," only narrowly missed deducing the existence of the **cementum.** This substance, which is identical with bone, forms a veneer to the root of the tooth, as shown in *Plate II.*

In passing to the consideration of the pulp cavity, it is necessary to premise that the descriptions of the permanent teeth in this chapter apply only to adult teeth. It will be seen later that the dentine of the roots of the teeth is formed by progressive deposition at the periphery of the pulp, the pulp becoming smaller as the dentine thickens. Until the full length of the root is completed, the size of the pulp cavity is rapidly diminishing by deposition of dentine upon its walls. Afterwards, apart from undue attrition of the grinding surfaces and certain pathological conditions, the contraction of the cavity is a very much slower process, and the following description of the permanent teeth may be taken to apply to any average adult tooth.

The **Upper Central Incisor.**—A section through the *neck* of the central incisor *transverse* to the long axis of the tooth, is found to be oval in outline, the longest diameter of the oval being the labio-lingual, and the longest transverse diameter being nearer the labial than the lingual side. This section shows the pulp cavity to be circular in outline, with a diameter about one third of that of the longest diameter of the section. It is situated centrally (*Fig.* 51).

Fig. 51.

Transverse sections of the *root* more towards the apex show a progressive tendency to a more circular outline as the apex of the root is approached, the pulp canal being circular and centrally situated. The calibre of the pulp canal becomes less in comparison with that of the root as the apex is approached.

A *vertical* section through the centre of the tooth in the *labio-lingual* direction shows the pulp cavity extending entirely through the root of the tooth, and into the crown for about one half to two-thirds of its length. It is widest at the cervical line, from which line it tapers in each direction to its terminations. It is thus seen that no constriction of the pulp cavity marks the distinction between the pulp chamber and the pulp canal (*Fig.* 52).

Fig. 52.

A *vertical* section through the centre of the tooth, in the *mesio-distal* direction, shows a similar relation of the pulp cavity to the root as in the foregoing section; but from the cervical line towards the crown, the pulp cavity instead of tapering to a point, broadens out to a flat extremity, which is parallel to the cutting edge of the tooth (*Fig.* 53.)

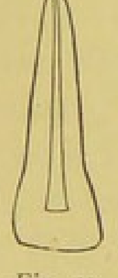


Fig. 53.

The **Upper Lateral Incisor.**—Sections of the upper lateral incisor show that the pulp cavity bears a similar relationship to the general outline of the tooth. In young teeth, both central and lateral, instead of the flat truncated extremity of the pulp cavity seen in the mesio-distal section, three little prolongations can be observed, which correspond to the prominences upon the cutting edges of newly erupted unworn teeth. These are the *horns* of the pulp cavity, and the projections of pulp tissue that fill them are termed the horns of the pulp (*Fig.* 54).

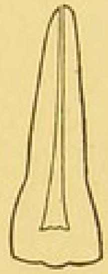


Fig. 54.

The **Upper Canine.**—The pulp cavity of this tooth bears much the same relationship to the *root* as does that of the incisors. In the cervical half of the root, however, it is not circular in transverse section, but much flattened mesio-distally. Towards the apex of the root it tends to become circular in outline.

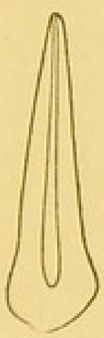


Fig. 55.

In the *crown* the pulp cavity resembles that of the incisors in the *labio-lingual* section, but in the *mesio-distal* it does not show an abruptly truncated extremity, but is rounded off (*Fig.* 55). Just as with the pulp cavities of the upper incisor teeth, the pulp cavity of the canine shows no marked distinction between the pulp chamber and the pulp canal.

The **Upper First Premolar.**—A *transverse* section through the tooth at the *neck*, shows that the pulp cavity bears the same relation to the outline of the section as does that of the canine (*Fig.* 56).

Fig. 56.

A *vertical bucco-lingual* section (*Fig.* 57) shows that the pulp cavity of this tooth consists of a pulp chamber and two pulp canals, the buccal and the lingual respectively.

The centre of the pulp chamber is near the level of the neck of the tooth. The pulp chamber itself roughly resembles the shape of the crown, a prolongation from it extending towards the buccal and lingual cusps—the *buccal* and *lingual horns* respectively. Of these the buccal is the longer and more pointed.

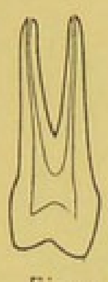


Fig. 57.

The pulp chamber of a tooth is said to have a floor, walls, and roof. The floor is that boundary of the chamber nearest the fangs. Thus in an upper tooth the floor of the pulp chamber is its uppermost boundary. The roof, of course, is the boundary opposite the floor, and the walls are mesial, distal, buccal, and lingual, according to their positions.

Extending from the pulp chamber of the upper first premolar into the fangs of the tooth are the pulp canals. These are usually funnel-shaped at their commencement, but rapidly become constricted, so that they are as narrow in the middle as in the apical third of the fangs. In old age they become constricted throughout, and they commence as minute openings in the buccal and lingual extremities of the floor of the pulp chamber.

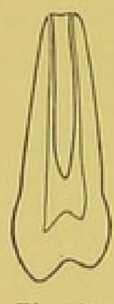


Fig. 58.

Even where the fangs of this tooth coalesce, the pulp canals as a rule remain distinct (*Fig.* 58).

The **Upper Second Premolar.**—A *transverse* section of this tooth at the neck indicates that the pulp cavity bears the same relationship to the outline of the neck as does that of the first premolar. A *median vertical bucco-lingual* section shows that the pulp chamber resembles that of the first premolar, except that the horns are more stunted. There is, however, as a rule, no marked distinction

Fig. 59.

between the pulp chamber and the pulp canal, which in this tooth is single (*Fig.* 59).

Transverse sections of the root at various levels show that the single pulp canal has on section a dumb-bell outline. Occasionally there are two pulp canals resembling those that occur in a first premolar, where the two fangs of that tooth coalesce.

The **Upper First Molar.**—A *transverse* section of this tooth at the neck, shows the pulp cavity at this point to be centrally situated, to roughly resemble the outline of the section itself, and to have a diameter about one third the length of the diameter of the section in the same direction.

A *vertical bucco-lingual* section through the mesio-buccal and lingual roots, shows the pulp chamber to roughly resemble the outline of the crown of the tooth, except that the horns of the pulp cavity are much more pointed than the cusps themselves. The width between the pulp chamber and the occlusal margin of the section is rather greater than that between the pulp chamber and the lateral margins of the section. In other words, the tooth is thicker between the pulp cavity and the occlusal surface, than between the pulp cavity and the buccal and lingual surfaces respectively.

Extending from the pulp cavity into the mesio-buccal and lingual fangs, are the mesio-buccal and lingual canals respectively. Of these, the lingual is the larger, particularly at its commencement, which is funnel-shaped. Both canals take a course which varies with the shape and inclination of the fang (*Fig.* 60). The floor of the pulp chamber between the openings of the lingual and mesio-buccal canals is arched, with its convexity toward the pulp chamber.

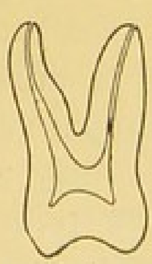


Fig. 60.

A *vertical bucco-lingual* section through the disto-buccal and lingual fangs shows a similar resemblance of the pulp cavity to the outline of the crown, but the floor of the pulp chamber is less arched in this section than in the last.

To the dental student the most important anatomical point in connection with the pulp cavity of this tooth, is the position of the openings of the pulp canals into the pulp chamber. This can best be ascertained by making a *transverse* section through the neck of the tooth, and carefully cleansing the pulp canals and floor of the pulp chamber. Looking upon the floor of the pulp chamber of a section thus prepared, the large funnel-shaped opening seen on the lingual side is the commencement of the lingual pulp canal. In the mesio-buccal angle of the floor, a small foramen marks the entrance of the mesio-buccal canal, and between this and the lingual canal is the arched floor of the pulp chamber. The position of the foramen which marks the opening of the disto-buccal canal is variable. Sometimes it is exactly in the disto-buccal angle of the floor of the pulp chamber, but it may be quite near to the opening of the mesio-buccal canal, indeed, not infrequently both the mesio- and disto-buccal canals open into a narrow groove at the buccal margin of the floor of the pulp cavity. Sometimes it is in the floor of the pulp chamber, at some little distance from its disto-buccal angle. In this situation, although it is easily discernable in the prepared section, it presents the most difficulty clinically. It may sometimes be found against the distal wall of the pulp chamber, at some little distance from the disto-buccal angle.

The **Upper Second Molar.**—The pulp cavity of this tooth bears the same relationship to the general outline of the tooth as does that of the first molar and it therefore needs no special description.

The **Upper Third Molar.**—When the shape of this is typical, its pulp cavity resembles that of the upper second molar; otherwise it frequently has but one pulp canal, which is large, and not distinguishable by any marked constriction from the pulp chamber.

The **Lower Central Incisor.**—In this tooth there is no marked distinction between the pulp chamber and the pulp canal, except the arbitrary one fixed by the terms of definition. Indeed, in a *vertical median labio-lingual* section it is seen that the pulp canal is wider than the pulp chamber (*Fig.* 61).

Fig. 61.

Transverse sections at the neck of the tooth, and at varying distances through the fang, show that the pulp cavity is much flattened mesio-distally, in this corresponding to the outline of the sections (*Fig.* 62).

Fig. 62.

The pulp cavity extends from a half to two thirds through the length of the crown, and as it approaches the cutting edge, narrows in its labio-lingual diameter, and widens in its mesio-distal, terminating in a flattened extremity corresponding to the cutting edge of the tooth (*Fig.* 63). Sometimes the mesial and distal walls of the pulp canal coalesce for some portion of their length in a vertical line down the centre. This results in a division of the pulp canal into two parts (*Fig.* 64).

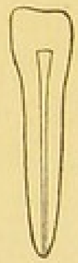


Fig. 63.

Fig. 64.

The **Lower Lateral Incisor.**—In this tooth the pulp cavity resembles that of the lower central incisor.

The **Lower Canine.**—The pulp cavity in this tooth resembles that of the upper canine, except that its coronal extremity tapers off to a fine point (*Fig.* 65).

Fig. 65.

The **Lower First Premolar.**—Sections of this tooth show that the pulp cavity bears the same general resemblance to the outline of the tooth as does that of the lower canine. A *bucco-lingual* section shows that the pulp cavity, intead of tapering to a point, is extended toward the lingual cusp, rendering the pulp chamber more capacious than that of the canine (*Fig.* 66). In all other respects the pulp cavities of the canine and first premolar are very similar.

Fig. 66.

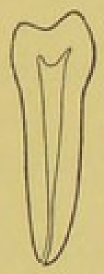


Fig. 67.

The **Lower Second Premolar.**—The pulp cavity of this tooth resembles that of the first premolar, except that the prolongation of the pulp chamber towards the lingual cusp is more pronounced, being often a well defined horn (*Fig.* 67). Not infrequently a slight constriction of the cavity marks the distinction between the pulp chamber and canal.

The **Lower First Molar.**—A *transverse* section at the neck of this tooth shows the pulp cavity to be almost square in outline, with mesio-buccal and mesio-lingual angless harp, and disto-buccal and disto-lingual angles rounded.

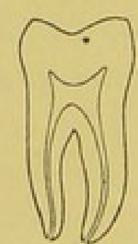


Fig. 68.

The *roof* of the pulp cavity is convex towards the cavity (*Fig.* 68). The four corners of the roof are the horns of the pulp chamber. The distal wall of the pulp chamber is convex horizontally, the other walls usually slightly concave. Vertically the mesial, distal, and lingual walls are convex; the buccal concave.

The *floor* of the pulp chamber is convex in the mesio-distal direction, concave in the bucco-lingual. Looking down upon the floor of the pulp chamber, the commencement of the mesial pulp canal appears as a slot-like opening in the angle formed by the floor and the mesial wall. It extends right across the floor of the chamber. On passing a bristle into this, it is usually found to divide into two very narrow canals, of which the buccal is the larger. Sometimes the mesial canal is double throughout its length, in which case its commencement is marked by two small foramina, one in the mesio-buccal angle of the floor of the pulp chamber, and the other in the mesio-lingual. The opening of the distal canal is funnel-shaped, and is situated at the distal end of the floor of the pulp chamber. Its widest diameter is the bucco-lingual.

Fig. 69.

The accompanying illustrations of *transverse sections* of the lower first molar at different levels, convey more clearly than any verbal description the relations of the pulp cavity (*Fig.* 69).

The **Lower Second Molar.**—The pulp cavity of this tooth requires no special description, as it exactly resembles that of the first molar.

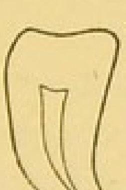


Fig. 70.

The **Lower Third Molar.**—In a typical tooth the pulp cavity of this molar resembles that of the first molar. Very often, however, this is a single-rooted tooth, in which case the pulp cavity is large and resembles the tooth in general outline (*Fig.* 70).

Special description of the pulp cavities of the *temporary teeth* is unnecessary. The pulp cavities bear a similar relationship to the outline of the teeth as do those of the permanent set, but it should be remembered that they are proportionately much larger, and therefore sooner penetrated from the surface of the tooth.

CHAPTER XV.

THE JAWS AND TEETH AT VARIOUS PERIODS OF LIFE.

THE late Sir John Tomes, in his inimitable *Dental Surgery*, wrote :—

"If the maxillæ of a *full-grown fœtus* be examined, it will be found that the union of the two halves both of the upper and lower jaws is effected by the interposition of fibro-cartilage, which allows a certain amount of motion between the parts thus connected. The alveolar margins are deeply indented, with large open crypts, more or less perfectly formed. The depth of these bony cells is sufficient only to contain the developing teeth and teeth pulps, the former rising to the level of the alveolar margins of the jaws. At this period the crypts or alveoli are not arranged in a perfectly uniform line, neither are they all equally complete. The septa, which divide into a series of cells that which at an earlier age was but a continuous groove, are less perfect at the back than at the front part of the mouth. The alveoli of the central incisors, both of the upper and lower jaws, are a little larger within than at the orifice, and this difference is made still greater by a depression upon the lingual wall of each for the reception of the pulp of the corresponding permanent tooth. They are divided from the crypts of the lateral incisors by a septum, which runs obliquely backwards, and a little inwards towards the median line. The sockets of the lateral incisors occupy a position slightly posterior to those for the central teeth, and are divided from the canine alveoli by a septum which proceeds obliquely backwards, and in the lower jaw (as regards the median line of the mouth) outwards. By the arrangement of these divisions, the alveoli of the central incisors are rendered broader in front than behind, and the relative dimensions of the sockets of the lateral teeth are reversed. The crypts of the canine teeth are placed a little anterior to those of the laterals, and nearly in a line with the central incisor sockets, giving to the jaws a somewhat flattened anterior surface. The septum dividing the canine from the first temporary molar crypt is not subject to the obliquity observed in the two preceding examples, but proceeds directly across from the outer to the inner alveolar margin, giving to the socket for the canine a greater breadth in front than behind, which peculiarity is still further increased by the anterior wall being bulged outwards. In these alveoli we have at present no depression provided for the pulps of the permanent teeth.

"The sockets for the first temporary molars are placed in the median line of the alveolar ridge; have a somewhat square form, with the outer margins inverted; and in the lower maxilla they are marked on their floors by a slight groove, in which the inferior dental nerve and artery lie. These enter the alveolus on either side through an aperture in the base of the septum, which divides imperfectly the first from the second temporary molar, and pass out to the external surface of the jaw through an orifice in the septum separating the canine from the former tooth.

"Posterior to the alveoli for the first temporary molars we have a large open socket, which, in the upper maxilla, has but a very imperfect posterior wall. Projecting inwards from the free edge of the outer and inner alveolar walls, we may observe small spicula, the rudiments of a septum, which is destined to divide the cavity into two distinct sockets, and thus separate the pulps of the second temporary and first permanent molar teeth, both of which at present occupy one large alveolus. The division usually takes place a little earlier in the lower than the upper jaw. The groove which marks the passage of the nerve and artery in the floor of the socket of the first temporary molar, is continued through the alveoli of the two posterior teeth, having entered by the inferior dental foramen, situated midway between the angle of the jaw and the edge of the inner wall of the alveolus of the first permanent molar, a little below the floor of the posterior part of the last alveolus.

"At this period the articular process of the lower jaw is scarcely raised above the level of the alveolar edge, while the angle is projected downwards, a little below the general level of the inferior margin of the jaw. The coronoid process rises at an angle of forty-five degrees from the alveolar edge, its ascent commencing at the anterior boundary of the socket of the first permanent molar. In the upper jaw the zygomatic process proceeds outwards from the anterior margin of the large open socket of the second temporary molar.

"It is necessary to notice, with some degree of accuracy, the relative position of these points, as in tracing the growth of the jaws, changes occur, which can be recognized only by a knowledge of the preceding conditions.

"The inferior border of the lower jaw in the nine month's fœtus is undulated; the angle and the point where the sockets of the first and second temporary molars join being the lowest points, while the intermediate parts of the margin are curved upwards. Viewed in profile, it will be seen that the alveolar margin projects over, and therefore forms a bolder curve than the inferior border of the jaw. At the junction of the two halves each portion is expanded, forming on the anterior surface a vertical process, which extends from the alveolar to the inferior margin of the maxilla, the greatest prominence being attained in the middle part of its course.

"The position of the zygomatic process has been already noticed, but the general characters of the alveoli remain to be described. In the upper jaw the inner alveolar ridge descends but little below the level of the hard palate, although the sockets have attained a considerable depth. At this age the antrum is represented by a depression on the outer wall of the nasal cavity, while the alveolar cavities extend to the base of the orbit, from which they are separated by a thin plate of bone; similar relations being maintained with regard to the anterior part of the nasal cavity.

"The temporary teeth at this period are partly formed. The central incisors are calcified through the greater length of the crown; but the lateral teeth are less advanced. The terminal points only of the canines are calcified, while the masticating surfaces of the first temporary molars are completed, excepting the enamel, which at this stage has not attained more than half its thickness, a condition common also to the more anterior teeth. The second temporary molar is represented by calcified cusps, which are united in a circle, the central part of the crown being as yet uncalcified. If examined in the recent state, it will be seen that in the front teeth calcification has advanced nearly to the base of the tooth pulp, which ends in a broad flat surface; while in the canines and molars the pulp extends a short distance below the terminal line of calcification.

"By dividing the mucous membrane and subjacent periosteum a little below the upper margin of the alveoli, both on the labial and lingual surfaces of the jaw, in a specimen which has been kept a short time in spirit, and then carefully raising the membrane from the surface of the bone, we shall be enabled to withdraw from their sockets the developing teeth enclosed in their sacs, which will remain firmly attached to the gum. The relative position of the dental sacs will be seen to correspond with the arrangement of the alveoli already described. The union of the external coat of the sac with the tissues of the gum, and of the lower portion of the pulp with the base of the sac, may be demonstrated."

This admirable description graphically represents the condition of the jaws and teeth at birth ; but it should be noted that in carefully prepared specimens it is found that the crypts containing the calcifying teeth are not open, but closed in by a thin and parchment-like layer of *ossific membrane*, which is usually destroyed in the preparation of the specimen, and evidently was in the case of those under observation, upon which the foregoing description was based.

Plate IX, *Fig. A*, which is a photograph of the skull at birth, shows the shape of the maxillary bones and mandible, and their relation to each other, and the proportion they bear to the rest of the skull. The labial and buccal walls of the crypts have been removed to show the extent to which the enclosed teeth are calcified.

During the next few weeks the changes that take place in the bony parts of the jaw can be roughly summarized as a deepening of the crypts containing the developing teeth, and an elongation of the rami of the mandible. The deepening of the crypts is brought about by the up-growth of their lateral walls, this being more marked in the incisor than the molar region.

Three months after birth the crypts of the temporary teeth are still covered in with the thin parchment-like

PLATE IX.

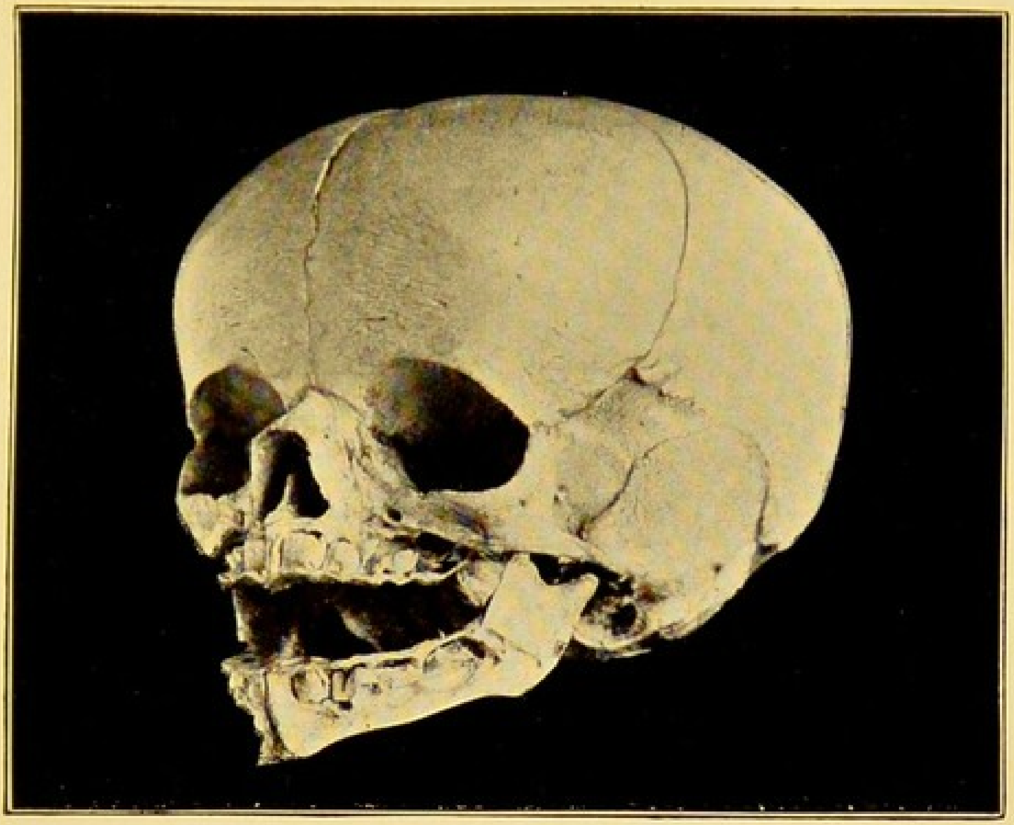


Fig. A.

Fig. B.

layer, which resembles that which at this period closes the fontanelles of the skull. So far as the author is aware the existence of this structure has never been pointed out by any dental writer. This is the more remarkable, as it has a physiological interest and a morphological significance, besides its obvious function in protecting the developing tooth germs. When it is removed, as generally happens in the preparation of a dry specimen, the septa between the crypts in the molar region are found to be much more advanced than at birth. The orifices of the crypts are much narrower than they were at birth, the labial and the lingual walls having approximated somewhat during their upgrowth. The septum between the upper second temporary and first permanent molars is complete, and that between the second temporary molar and first permanent molar nearly so. At three months, then, all the temporary teeth are enclosed in separate crypts, except the lower second temporary molar, which is only partly cut off from the lower first permanent molar. The student will notice that this differs from the account in Tomes' *Dental Surgery* quoted above, in which it is stated, "the division takes place earlier in the lower than the upper jaw."

To the dental student the most interesting metamorphosis during this period is that which takes place in the tooth germs themselves. The calcified cusps of the teeth are thickening, and gradually extending over the sides of the papillæ towards their bases. Upon the lingual walls of the crypts near the floor, a depression appears, which gradually increases in size, and as it does so it becomes cut off from the crypts by the upgrowth of bone from the floor, which converts what was originally a depression in the crypt wall into a separate crypt. This contains the germ of the permanent tooth. A small foramen however remains, which transmits a narrow neck of soft tissue, which becomes extended as the separation widens between the temporary tooth and its successor. This was termed by the earlier writers the *gubernaculum*, and was supposed by them to be the means by which the permanent tooth was directed to its appointed place in the mouth.

At *six months* the condyles of the mandible have elongated, so that their articular surfaces are considerably above the level of the alveolar ridges. At this period separate bony crypts are found on the lingual side of the incisor teeth, for the lodgment of their developing permanent successors, but these crypts communicate by fairly large orifices with the crypts of the temporary teeth.

A vertical section through the developing tooth sacs, shows the various structures to be in the following relation to one another. Superficially the *oral mucous membrane* and *submucous tissue*; then the **ossific membrane**, which closes in the crypt; beneath this, immediately in contact with the calcified cusp of the tooth, is the **enamel organ**, then the **calcified** portion of the **tooth**, and beneath this the **dentine papilla** (*dentine germ* or *pulp*); then the **floor** of the **tooth sac**, which structure passes up round the sides of the foregoing dental tissues, enclosing them, and is adherent to the under surface of the ossific membrane, and is continuous with the membrane (periosteum) lining the external bony surface of the jaw. The **enamel organ**, the existence of which was first pointed out by John Hunter, is adherent to the tooth sac, and, to the naked eye, is indistinguishable from it. It is said to be non-vascular, but the author has found it coloured after using fine injection in the case of pigs. It is thickest over the occlusal surfaces of the developing crowns of the molars, but in the case of the incisors and canines, the greatest thickness is over the lingual aspect of the crown. The enamel organ decreases in thickness with the development of the enamel. John Hunter was the first to demonstrate by his experiments upon young animals, that the dentine is first formed by what is now known as the **dentine papilla**, and the enamel then secreted upon it by the enamel organ. The consideration of this matter is best postponed until the development of the permanent teeth is described, when it can be traced from its commencement.

At the age of six or seven months, and sometimes earlier, we find the first indication of the change that takes place in the crypts of the teeth to allow of the elevation of the crowns of the latter. This takes place first in the incisor region, the edges of the labial walls of the crypts of the central incisors wasting away, so that in the dry specimen, the cutting edges and part of the labial surfaces of these teeth are exposed. The physiological process by which this wasting away is effected, is termed **absorption**. The enamel of the teeth in the crypts, when this absorption is found to have occurred, has a glistening, vitrified appearance, which contrasts strongly with the dead white surfaces of those contained in the crypts, which as yet show no signs of absorption. It is therefore a fair inference that **amelification** (the term applied to the process of enamel formation) is always completed before absorption commences. Up to the time of the completion of the enamel, the calcified crown of the tooth is quite easily separable from the dentine papilla, and the enamel organ from the enamel. After the enamel is complete, the constriction which forms the neck of the tooth becomes marked, and the separation of the crown from what should be now termed the **pulp** is less easy to effect.

Coincident with the formation of the roots of the teeth, elevation of their crowns appears to take place. That is to say, if a number of specimens be examined, the degree of extrusion of the crown of any particular tooth will, as a rule, but not invariably, correspond with the degree of development of its root. Examination of a recent specimen, in which the crowns of the incisor teeth have commenced to move, shows that the superjacent soft tissue is absorbed in the same manner as the bony wall of the crypt, wasting away imperceptibly as the crown comes to the surface. When the crown of the tooth is just about to emerge from the gum, the process can be most instructively observed in the living subject. Some time before the tooth actually makes its appearance, the tissues of the gum overlying it are raised slightly above the level of the surrounding parts. There is normally no indication of inflammation, and when the tooth is just about to penetrate the superficial layer of the mucous membrane—or, to use the popular term, is on the point of being "*cut*"—the mucous membrane is raised sharply over its cutting edge, and is white in colour ; so much so that the tooth appears to have come through when there is still a thin layer of membrane over it. When the tooth is cut, if the surface of the mucous membrane be carefully dried, the minute orifice in the gum tissue is seen to be circular in outline, and its margin shows no appearance of abrasion, nor can it be made to bleed more easily than other parts of the gum. This orifice rapidly enlarges, so that in the case of the lower incisor teeth, in two or three days the whole of the cutting edge may be exposed. The rapidity with which the tooth subsequently rises from the gum varies much in different individuals, and in the same individual the movement is not regular and continuous but intermittent.

It is extremely difficult to determine with any pretence to accuracy, the exact rate of progress in any particular tooth, because there is no convenient fixed point from which measurements can be made. Occasionally it is very rapid, for in one case the author had under observation, the apparent movement in a newly-erupted lower incisor was a quarter of an inch in two days—this being preceded and followed by a period of several days when the tooth seemed quite stationary. The term **eruption** is used by dental writers with two distinct meanings. It is sometimes applied to the passage of the tooth through the superficial layer of the oral mucous membrane, and is equivalent to the expression "*cutting*," as used in this connection. At other times it is the term applied to the whole progress of the crown of the tooth in its journey from the crypt in which it was developed, to its final destination in the mouth. It would be better if the term eruption were used exclusively in the latter sense, and the more popular expression employed to denote the episode of the emergence of the tooth from the gum.

After the enamel covering of the dentine of the crown is complete, the dentine of the root is covered with cementum. The only structure that can form this is the inner layer of the tooth sac, as that is the only structure in contact with the newly formed dentine. John Hunter's experiments, referred to in an earlier chapter, showed that the dentine is formed of concentric lamellæ. "I find," he wrote, "that the bony part of a tooth is formed of Lamellæ, placed one within another. The outer Lamella is the first formed, and is the shortest ; the more internal Lamellæ lengthen gradually towards the fang, by which means, in proportion as the tooth grows longer, its cavity grows smaller, and its sides grow thicker." Another result of this method of formation, is that the pulp cavity narrows in its coronal half relatively more quickly than in the other, and hence we find that the fangs of teeth which are almost complete are widely open at their extremities (*Fig.* 71). The newly formed edge of dentine is therefore the thinnest. In appearance it resembles decalcified bone, being semi-transparent and quite soft and flexible, yielding to the slightest pressure.

Fig. 71.

In the case of the molar teeth there is no appearance of any division of the dental papilla or pulp until the crown is nearly complete. As the calcification of the crown approaches completion, the thin margin of calcified material at its neck turns inwards at two opposite points in a lower molar, and at three points in an upper molar. The points in the case of a lower molar are situated at the middle of the buccal and lingual walls, and in the case of an upper molar, at the middle of the buccal wall, and at the middle of the mesial and distal walls respectively. These turned-in margins extend rapidly towards each other until they meet, dividing the dental papilla or pulp (*Fig.* 72). This forms the commencement of the fangs, each of which then grows in the manner described above by the addition of dentine internally, and cementum externally. The fangs of the upper first premolar originate in a similar manner.

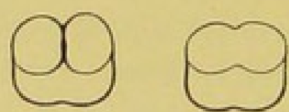


Fig. 72.

Although all the teeth are developing simultaneously, they are not, of course, at equal stages of development, but retain much the same relationship to each other in this respect as they had at birth. Exactly what that relationship is at the various periods, is better conveyed

PLATE X.

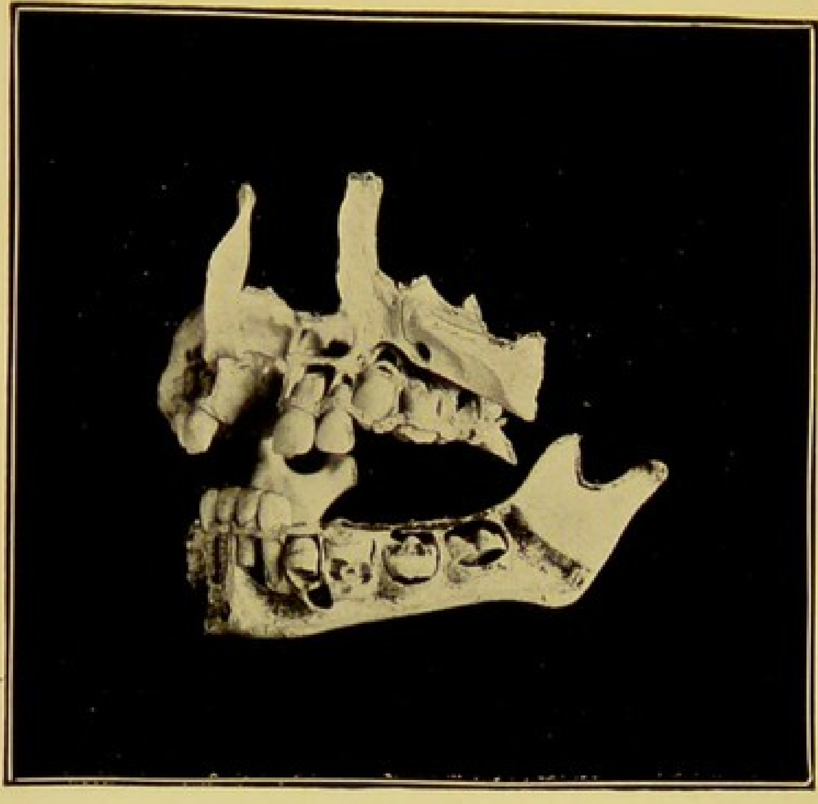


Fig. A.

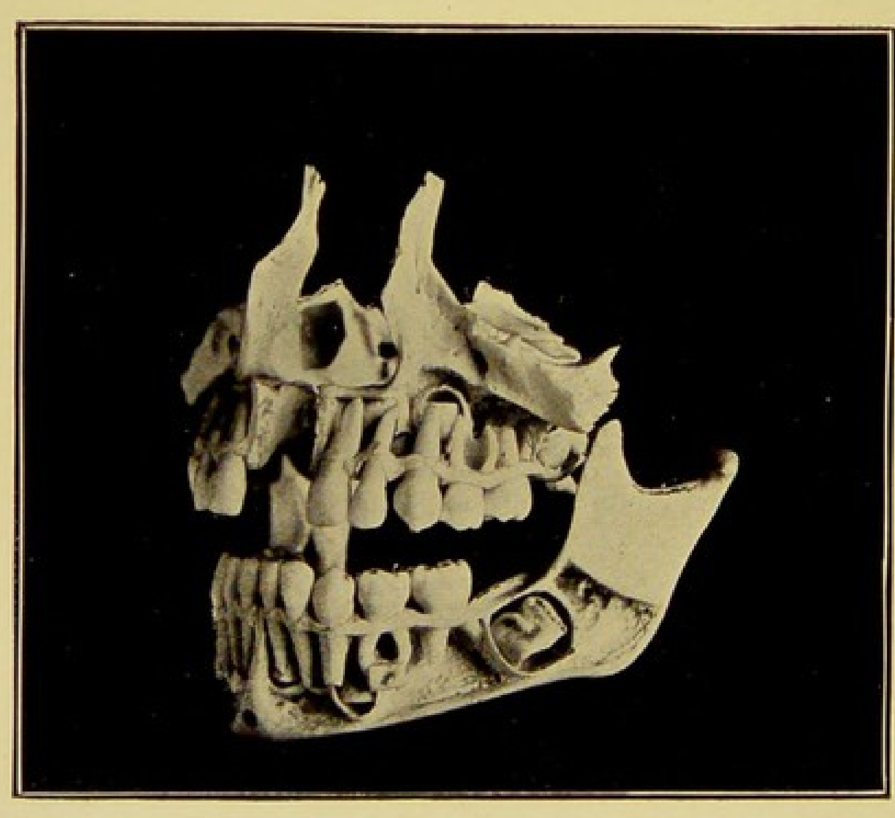


Fig. B.

by the illustrations (*Plate IX*, *Fig. B*, and *Plate X*, *Figs. A* and *B*), than by verbal description. *Plate IX*, *Fig. B* is a photograph of a preparation of the jaws of an infant nine months old. The bone covering the crypts externally has been removed, showing the crowns of the teeth. *Plate X*, *Figs. A* and *B*, are photographs of preparations of the jaws of children, stated to be twelve months and two years old respectively, similarly treated. The extent of development of the various teeth of the temporary set at each period is so clearly shown, that detailed description is unnecessary. The student should note, however, that the space in the crypt above each developing crown which is occupied by the enamel organ, diminishes as the crown develops, while that below, which is occupied by the base of the dental pulp, is never altogether obliterated, and is often considerable, even when the tooth is in the eruptive stage.

The alterations which have taken place in the jaws are not so obvious from inspection of the photographs. These changes have been so admirably sketched by the late Sir John Tomes in his *Dental Surgery*, that the student should refer to that work, as the method of investigation was characteristically thorough and extremely interesting. The conclusions arrived at may be briefly summarized as follows :—

The curve formed by the inner alveolar ridge of the mandible (for it was with reference chiefly to the changes in the lower jaw that the investigation was carried out) undergoes no enlargement, this being demonstrated by measurements made of the distance "between the junction of the septa between the sockets of the first and second temporary molars, and the inner plate of the alveoli of either side," and also from the centre of the line joining these points to the genial tubercles.

The most remarkable change that takes place in the mandible at this age is the rapid upgrowth of the alveolar portion in the incisor region, which is accompanied by some thickening which is due to the advanced position of the anterior alveolar plate. Sir John Tomes attributed this advance of the anterior plate to "addition of bone to the anterior surface," but in the author's opinion it is more probably due to the fact that as the sockets grow up, their front walls, with the developing teeth, assume a more anterior position. Any growth which may take place at the symphysis is so slight as to be practically negligible. The length of the body of the mandible is steadily increased posterior to the mental foramen, by the addition of bone to the angle of the jaw. It is not within the purpose of the present treatise to enter into the physiology of the growth of the jaws, but it is necessary to state here that Sir John Tomes concluded from his investigations that there is no interstitial growth of the jaws, and that the increased length of the mandible is achieved by external deposition of bone, concurrently with an absorption of the anterior border of the coronoid process. He accepted Kölliker's views, which were that the articular cartilage of the mandible is in one respect analogous to the cartilage which intervenes between the epiphysis and apophysis of the long bones, to the growth and subsequent calcification of which the elongation of the bone is due. The direction of the condyle during infancy is such that its elongation, together with bone deposition at the angle and posterior part of the mandible, very materially adds to the length of the two halves of the bone; and absorption of the anterior border of the coronoid process affords space for the addition of teeth to the extremities of the dental arches. If this were not stated here, the student would naturally assume that the increased space between the second temporary molar tooth and the anterior border of the ascending ramus, was gained by interstitial growth of the body of the bone. The extremely slight additions to the lower border of the body of the mandible are rendered obvious by the illustrations (*Plate IX*, *Fig. B*, *Plate X*, *Figs. A* and *B*).

The illustrations also show very clearly the alteration that takes place in the angle formed by the body of the mandible with the ramus, the increasing length of the ramus, and the greater comparative increase in the alveolar part of the body in the incisor region. They also show that each new lower molar of the permanent set is developed practically in the root of the coronoid process.

The preponderance of alveolar growth maintained in the incisor region during infancy, renders possible the correct occlusion of the temporary teeth ; for it is obvious that if the alveolar part of the jaws increased as quickly in depth in the molar as in the incisor region, the incisor teeth would be prevented from occluding by the premature occlusion of the molars. This, indeed, would happen even as things are, if it were not for the gradual lengthening of the ramus. The mechanism by which the exact balance of growth is preserved, is an interesting problem in dental physiology, the study of which the dental student might well pursue with profit to himself and advantage to his profession.

In works upon dental anatomy published in recent years, very little has been written upon the correlative development of the other cranial bones, which must of necessity take place coincidently with that of the mandible. For example, the backward growth of the mandible carries the condyles further apart, because the opposite halves of the bone are not parallel but divergent. If the separation between the glenoid cavities of the temporal bones were not coincidently widened, the proper relationship of those cavities with the condyles of the mandible would be lost. The late Mr. Hilton threw a great deal of light on this subject. He wrote: "The sphenoid bone forms the centre around which all the other bones both of the cranium and face are developed. It is truly and literally indeed a wedge, as its name implies; and thus impacted or wedged in amongst all the other cranial and facial bones, its progressive development, spreading its different processes out in all directions, plays a most important part, not only in determining the adult configuration of the skull, but in adapting the final conformation of the organs of the face to the increasing perfection of their associated functions. The mouth, nose, orbits, and pharynx, are all more or less directly influenced, and contemporaneously rendered more perfect in form, by the complete development of this bone.

"The primary idea, or primary intention of the development of the sphenoid, seems chiefly with reference to the masticatory function; but in the changes that it produces in the direction of the cranial and facial bones, it may not inaptly be compared to the scaphoid bones of the carpus and tarsus; for in its growth and final development it effects for the cranium and face precisely the same object that these bones effect for the hand and foot.

"Like these bones, then, the growth and completion of the sphenoid, in spreading out the cranium, and in enlarging the cavities of the organs belonging to the face, supplies the deficiency of the muscular tension, which in other parts of the body has so large a share in determining the final or perfect forms of the bones."

From this it is abundantly evident that the extent of the separation between the condyles of the mandible finally attained, is dependent upon the growth of the sphenoid bone, which by widening the base of the skull increases the distance between the glenoid cavities.

The observations of the late Sir John Tomes upon the growth of the maxillæ and mandible during second dentition have not, so far as the author is aware, found a place in any recent work upon dental anatomy. They are too valuable and too interesting to admit of curtailment. He wrote :—" The position of the tubercles for the attachment of the *genio-hyoglossus* and *genio-hyoideus* were referred to in a nine-months' subject, as parts suffering little change of position during the period of growth. In the specimen there described, it is found that if the jaw be placed upon a flat surface from which to make measurements, the distance from the upper part of the tubercles to the level of the lower border does not exceed $\frac{3}{12}$ths of an inch. In a jaw from a subject seven years old, the corresponding part measured $\frac{6}{12}$ths of an inch ; in an example of fourteen years, the distance had not increased. In another specimen, aged twenty-one years, the $\frac{1}{24}$th only had been added. But if, instead of measuring from the foregoing points, the distance from the upper tubercles to the alveolar margin be taken, the following results will be obtained. In the nine-months' subject, $\frac{4}{12}$ths ; in the seven years', $\frac{8}{12}$ths ; in the fourteen years', $\frac{10}{12}$ths ; and in twenty-one years', $\frac{10}{12}$ths of an inch.

" These dimensions are taken from well-formed jaws of medium size, and may be regarded as typical examples of the progressive changes in the parts measured during the periods embraced by the several specimens. It is thus shown that, ordinarily, the depth of the jaws below the upper *spinæ mentales* is doubled between the ages of nine months and seven years, the amount gained being

$\frac{3}{12}$ths of an inch; and that after the seventh year, but little change takes place at this point in respect to the mere depth; while the parts above the *spinæ mentales* during the same period increase from $\frac{4}{12}$ths to $\frac{10}{12}$ths of an inch, the maximum height being attained by the fourteenth year. In the great majority of specimens a small foramen is situated in the median line, immediately above the upper pair of tubercles, and when present this may be selected as a point from which to take the foregoing dimensions. Unfortunately it is sometimes wanting, or is represented by a similar aperture below the spinæ mentales. In a series of jaws taken from very old subjects, in whom the teeth had been lost and the alveolar processes had been absorbed, the foramen holds to its original position. If these specimens are subjected to measurement, we find that this aperture is within from the $\frac{1}{12}$th to $\frac{3}{12}$ths of an inch of the alveolar margin, showing a loss in the oldest jaw of $\frac{9}{12}$ths, while it is separated from the lower border of the jaw by $\frac{6}{12}$ths of an inch, the loss in this direction being inappreciable.

"If a horizontal line be drawn intersecting the upper pair of tubercles and the mental foramina, or if a series of jaws of different ages be sawn through in the line indicated, it will be seen that but comparatively little change, either of form or of dimension, has taken place after the period when the two halves became anchylosed, excepting such as may have resulted from the much greater thickness and solidity which have been acquired in the part cut through.

"If the mental foramen be taken as a centre from which to measure the depth of the jaw, very different results will be obtained as respects the relative rates of increase above and below that point. Thus in the nine months' specimen we have $\frac{2 \cdot 5}{12}$ths below, and $\frac{3 \cdot 5}{12}$ths above; in the seven years' specimen, $\frac{4}{12}$ths below, and

$\frac{6}{12}$ths above; in the fourteen years', $\frac{6}{12}$ths below, and $\frac{6}{12}$ above; and in the twenty-one years', $\frac{7}{12}$ths below, and $\frac{7}{12}$ths above.

"These dimensions show either that the jaws have increased in nearly an equal ratio above and below the opening, or that the position of the foramen has been changed during growth. If the outer surface of bone be removed, so as to expose the inferior dental canal throughout its length, in a series of specimens of progressive ages, the manner in which the change of position of the mental foramen has been effected will be seen. In the nine months' the opening is upon a level with the course of the canal, but with the increase of bone upon the surface, during growth, the aperture becomes gradually raised to a higher level; not, however, by the direction of the canal itself being altered, but by an increased length corresponding to the increased thickness of the outer portion of the bone. The canal in the recently-formed bone is directed upwards and outwards, its position as regards the previously-formed part being rectangular. The angle so produced corresponds in its position to the foramen in the young subject. If the examination be extended to aged edentulous jaws, it will be found that a large portion of bone has been removed from the surface, and that the terminal portion of the dental canal has been consequently shortened, and the foramen brought nearer to the lower border of the jaw.

"With the exception of additions to either end during the period of growth, and the consequent alterations of the apertures, there does not appear to be any evidence in favour of the supposition that the position of the canal is changed, either at the epoch of second dentition, or indeed at any other time.

"In the nine months' subject, when the anterior teeth are about to be cut, the canal is nearly straight from end to end, the whole length corresponding to that portion which, in the adult, lies under the bicuspids and first permanent molar, and forms scarcely more than one-third of its entire length. The straightness of the anterior third is permanently preserved in all the specimens I have examined. The middle third is slightly curved upwards, and the posterior portion is still more curved, and if prolonged, would pass through or immediately in front of the articular process. The course of this posterior third traverses the ascending ramus of the adult jaw rather obliquely, and, in the great majority of cases corresponds with the direction of the condyle rather than that of the ramus. These points have been entered upon with some degree of minuteness, in consequence of their affording evidence as to the manner in which the jaw becomes lengthened to so great an extent by additions at its posterior portions.

"In tracing the growth of the jaw backwards, we may take the inferior dental canal as marking pretty accurately the line of growth followed by the condyle, and the external oblique line as that which has been followed by the base of the coronoid process.

"In examining a series of suitable preparations, it may be seen that the crypts for the permanent molar teeth are, in the first instance, formed internal to the ridge of bone which forms externally the base of the coronoid, and that this ridge is continuous with the oblique line of the jaw. Absorption in this neighbourhood appears to stop short before reaching the absolute base, and leaves a trace of the ridge alluded to; the trace constituting the oblique line within which the alveoli of the molar teeth grow up.

"The manner in which additions are made to the posterior border of the jaw has been described in connexion with the growth of the jaws of very young subjects. During the period of youth the process is continued, and as the subject approaches manhood, the angle becomes fully pronounced. At the same time, the mental prominence and the points for the insertion of muscles attain their permanent characters. In each case the increased size is produced by sub-periosteal development upon the pre-existing bone. The development of the jaw may, in some respects, be compared to modelling. Portions of new tissue are laid upon that already formed, and reduced to the fitting size and shape, and again renewed at such points as the attainment of the ultimate form of the part may require. . . . .

"Of the different parts of the sphenoid bone, those which undergo the greatest change during the period under consideration, as regards size, and which are also the most directly connected with the present enquiry, are the pterygoid plates. These parts increase to the extent of one-third of their ultimate length, between the ages of seven and twenty-one years. In a specimen of seven years, the anterior surface of the pterygoid process is separated from the first permanent molar by a distance scarcely exceeding a quarter of an inch, and the nascent second molar lies in the tuberosity, in great part external to the sphenoidal processes. The space, at present so inconsiderable, was, before the adult form is acquired, to be increased fully two-thirds, accompanied by an increased length of the pterygoid plates, the general direction of which remains unchanged. The general principles which have been pointed out as pertaining to the development of the lower jaw, may be applied to those facial bones which are connected with the masticatory apparatus. The tuberosity is to the upper, what the base of the coronoid process is to the lower jaw. From this point the alveolar line is lengthened. In the specimen last mentioned, the second molar is buried high up in the tuberosity. Soon after the expiration of the twelfth year, the distance between the pterygoid process and the first molar will have increased sufficiently to allow the second molar to take its place in the dental line, and by the expiration of the twentieth year the third molar is usually found in its normal position. Up to this period the facial bones are connected to each other and to the bones of the cranium by sutures only; and in the soft tissue within these, development of bone takes place.

"The maxillary bones, while their processes are increased in length, are moved bodily forward; the rate of growth keeping pace with the increase at the tuberosity. Coincident with development, the modelling of certain parts by superficial absorption is carried on. By this process, the anterior surface of the lower border of the malar process is removed, and thus thrown backward. In the seven years' specimen it lies immediately above the anterior third of the first molar; at twenty-one it holds a similar position with respect to the second molar, thus showing a recedence equal to the width of one tooth.

"As respects the changes of form and position which the glenoid cavity undergoes during growth, but little need be said. Here we have articular cartilage, beneath which the required amount of bone is slowly developed in the same manner as in the sub-articular cartilage of the lower jaw.

"The growth of the alveolar process need not be again referred to.

"After the teeth are lost, the upper jaw undergoes great change both in size and in form; not, however, from what is called interstitial absorption, but simply from progressive superficial absorption. The alveolar processes are gradually lost, and the whole bone is reduced in thickness. The pterygoid plates of the sphenoid bone become greatly diminished in size and strength, while the glenoid cavity loses its strongly pronounced margin, and hence becomes flattened."

The foregoing description of the changes that take place in the jaws is quoted at length here, because the author, who has gone carefully over the same ground, finds very little to add, and nothing to criticize, except that the writer dated the eruption of the teeth as commencing somewhat later than the time given by more recent authorities. This point has already been discussed in a previous chapter.

There is very slight mention of the glenoid cavity. This, the student who has adopted the author's recommendation, and rendered himself familiar with the bones of the cranium, will remember is the articular surface upon the temporal bone upon which the condyle glides. Its form in the adult has been described in the chapter on the temporo-mandibular joint. In the infant at birth it is very little more than a flat facet. There is no distinction of glenoid cavity and articular eminence. During early childhood the surface gradually increases in extent, but up to the time of puberty the glenoid cavity is very shallow, and the eminence very slight. The student should remember that the path followed by the condyle of the mandible is not determined by the outline of the glenoid cavity and articular eminence as these are seen in the dry bone, for both the cavity and eminence are covered with cartilage in the recent state; and the disposition of this cartilage varies considerably, being, in fact, determined largely by the shape and arrangement of the dental arches, and the size and shape of the mandible. The intervention of the movable, inter-articular cartilage, moreover, so modifies the path of the condyle, that a tracing of its forward movement during depression of the mandible does not, as a rule, exactly coincide through the whole of its extent with a tracing of its return movement.

The changes that take place in the jaws have been described in some detail because, at the present time, our knowledge of the actual means by which these changes, are brought about is very scanty, and in view of theories that will certainly be put forward in the near future, the student should be in a position to judge exactly how far these theories agree with actual anatomical facts.

To return to the teeth, when a child is at the age of twenty-eight months or thereabouts, all the temporary teeth should have arrived at that position in the mouth which best enables them to perform their functions; in other words, should bear the relation to each other described in the chapter on occlusion. Dissection reveals that the roots of the teeth are, some of them, still far from completion, and as this is a point upon which authorities differ considerably, it should be carefully noted. Recent American writers state that the calcification of the second temporary molars, both upper and lower, is completed at the twenty-second month after birth—that is to say, at about the time, or rather earlier than, these teeth are cut. They date the completion of calcification of the temporary canines at twenty-four months. The late Sir John Tomes, on the other hand wrote:—

"If we now pass to maxillæ from a subject forty months old, it will be seen that the whole of the temporary teeth have taken their normal position in the jaws, and appear complete; but if the roots are examined the inaccuracy of this conclusion will be discovered. The incisors are the only teeth in which the fangs are completely formed. The canines are destitute of about one third, the first temporary molars of a fifth, and the second temporary molars of at least one-half of their normal length. The next specimen in my series was taken from a subject who died at the age of four years and one month. In these jaws the incisor teeth are the only ones which are really perfected. The fangs of the others are slightly deficient in length, and are hollow at their extremities. Four or five additional months would probably have served for their completion. At the commencement of the sixth year the temporary teeth are all fully formed, a condition which is most likely attained six months prior to this period; but I have not specimens of determined ages, ranging between the fourth and fifth year, suitable for the elucidation of the point. Seeing, however, that at the termination of the fourth year the development of the first set of teeth is not completed, and that at the commencement of the sixth year these teeth are perfectly formed, it may be assumed that at four and a half years of age the primary dentition is completed."

The discrepancy here is very great; the American authorities dating the completion of calcification two years and six months earlier than the great English authority. The same interesting point arises here that was discussed in an earlier chapter. It is scarcely conceivable that so accurate an observer as Tomes could have made an error of more than twenty-four months—for the author would here remark that the truth with regard to English teeth lies between the two estimates thus contrasted. At the same time, if it be really a fact that the temporary teeth calcify so much more rapidly now than was the case three generations ago, it is one which is worthy of more attention and careful investigation than it has hitherto received.

If the student will refer again to *Plate X*, *Fig. B*, he will note that the calcification of the molars and canines is not complete, although from the appearance of the dental arches and the extent of calcification of the first permanent molar, some months have elapsed since the eruption of the temporary teeth. The specimen from which the photograph was taken is in the museum of the Odontological Society of Great Britain, and it is stated to be from a subject two years old.' In the author's opinion the stage of development shown is that usually found in subjects about thirty-six months old.

The author has never yet seen an instance in which the calcification was complete at twenty months, but he is of opinion, on the other hand, that "the primary dentition is completed" much earlier than "at four and a half years of age."

The following table shows approximately, the dates of the completion of the calcification of the temporary teeth.

MONTHS.	TEETH.
14.	Lower Lateral Incisors
18.	Upper Central and Lateral and Lower Central Incisors
28.	Upper and Lower First Molars
38.	Upper and Lower Canines and Second Molars.

Having now traced the temporary dentition to its completion, let us consider the permanent teeth.

At birth the tooth sacs of the permanent incisors are contained within the same crypts as the developing temporary teeth. They lie against the lingual surface of the crowns of the temporary teeth, the sac of the temporary tooth of course interposing. They are very much smaller than the crowns of the temporary teeth. At this age the sacs of the permanent canine teeth are so small as to be nearly indistinguishable to the naked eye, but they are found to lie against the lingual surface of the crowns of their temporary predecessors. The premolar germs are also minute, and lingually situated with regard to the temporary molars in the crypts of which they lie. The germ of the first permanent molar has, however, acquired considerable dimensions, being slightly larger than that of the temporary molar with which it lies in contact.

If we dissect the sac of a permanent molar, we find it contains two distinct structures separable from each other. Springing from that part of the sac which is in contact with the floor of the crypt is the dental papilla. This resembles in shape the occlusal half of the crown of the tooth it helps to form. Its free surface presents elevations which correspond to the cusps of the completed tooth, and the summit of each elevation shows indications of calcification having commenced. Fitting so closely over the dental papilla that it forms an exact mould of its free surface, is the enamel organ. The appearance and structure of the dental papilla and enamel organ of the permanent teeth, resembles that of the corresponding structures of the temporary teeth which have been already described. A marked difference between the first permanent molar germs at birth, and those of the temporary teeth, is that while the latter have hard calcified caps intervening between the enamel organ and dentine papilla, in the former the enamel organ and dentine papilla are in contact, calcification having proceeded no further than the extreme tips of the eminences of the dentine papilla, which seem to be converted into translucent cartilaginous points, consisting only of dentine upon which enamel has not yet been deposited. From these points calcification proceeds over the surface of the papilla, the ridges proceeding from the eminences calcifying first. The process may not inaptly be compared with the descent of the snow-line in winter upon the contiguous peaks of a mountain. At first the tips only of the peaks are covered, but slowly the white caps descend, first along the highest ridges between the peaks, finally into the intervening valleys, until the whole mountain top is snow-clad.

Very shortly after the dentine has extended beyond the extreme tips of the eminences of the dentine papilla, enamel is secreted upon it by the enamel organ. Dentinification, however, always precedes amelification, so that the extreme edge of the calcifying cap consists of dentine alone, and is of cartilaginous consistency.

In like manner at later periods, the crowns of the other permanent teeth calcify, and their development in the later stages differs in no essential point from that of the temporary teeth already described.

The student must note the interesting fact that the tooth germs do not commence the work of calcification until the dentine papilla has nearly attained the dimensions, at its free surface, of the crown of the tooth to be formed by it; and further, with the exception of the first molars, none of the permanent tooth germs have attained their full development at birth. This post-natal increase in all the formative tissues of the tooth is a point of peculiar interest, and one that throws some light upon the factors that determine the development of the jaws.

At the age of about twenty months the tooth germ of the second permanent molar, both upper and lower, is visible to the naked eye. It appears to be an offshoot from the junction of the neck of the sac of the first permanent molar with the superficial oral tissue. Like the other permanent germs, it is at first contained within the crypt of the tooth from the neck of the sac of which it appears to be an offshoot. Like them, too, it appears

PLATE XI.

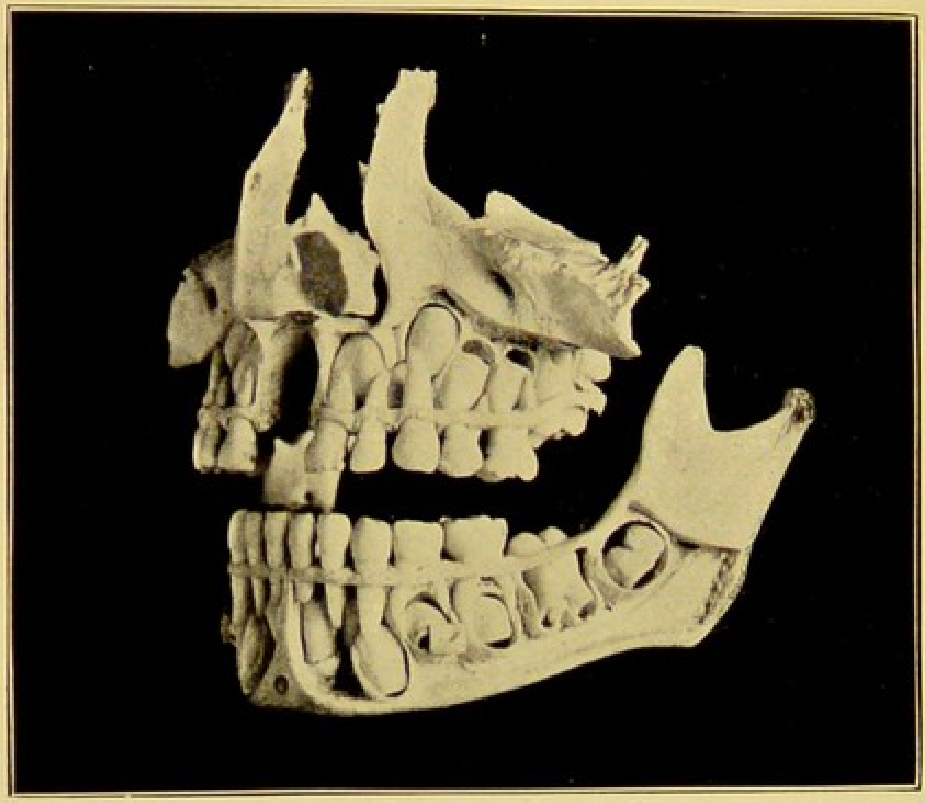


Fig. A.

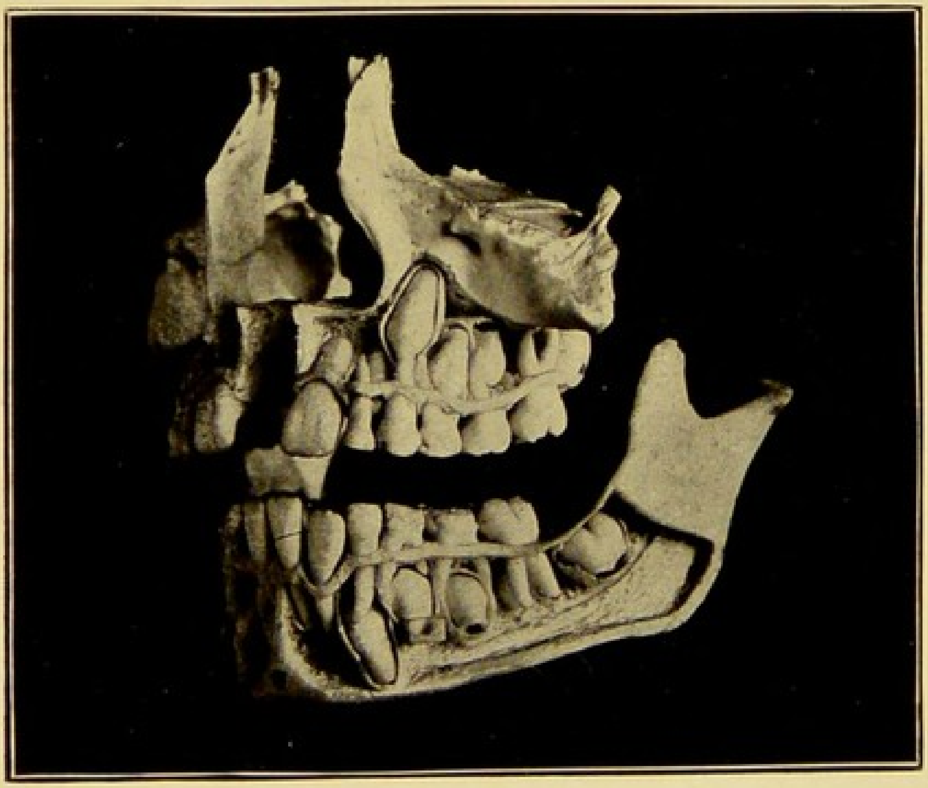


Fig. B.

to make for itself a depression in the wall of the crypt, which enlarges with the follicle it contains. Similarly, too, an upgrowth of bone from the floor of the crypt converts what was originally a depression in the crypt wall into a separate crypt, in which the new tooth germ undergoes the transformation which has been already described in the case of the other teeth. To avoid reiteration, it is as well to state here that the third permanent molar is formed at a later period in the same manner, by an extension backwards from the crypt of the second molar. It has been questioned whether the recession of the permanent tooth germs from the crypts in which they originate is apparent or real. It has been urged that what appears to be movement on the part of the germ is really movement of the tooth with which it has been in contact, the germ being left in its original situation. Now this obviously cannot be the case with the second and third molars, and there is therefore no reason for assuming it to be so with the incisors, canines, and premolars. The gubernaculum remains to mark the connection between the molar teeth, and so long as the sacs of the second and third molars remain intact, their gubernacula can be dissected out as far as the parent teeth, their direction being nearly horizontal.

When the temporary teeth are fully formed, and before their roots have commenced to show any sign of the wasting that has already been referred to as resorption, the relationship of the crowns of the permanent teeth to their temporary predecessors is of considerable importance, because it throws some light upon the method of development of the jaws. If the student refers to *Plate XI, Fig. A*, he will be better able to understand the following description, because, although the preparation there illustrated is from a child about six years old, and the temporary teeth show signs of resorption, the relationship of the teeth is sufficiently near that which obtains at the period about to be described for the illustration to be of use for descriptive purposes.

Above, and to the lingual side of the roots of the temporary incisors, are the crowns of their permanent successors. The floors of the crypts containing them also form part of the floor of the nose, so near are these teeth to the nasal cavity. The permanent lateral incisor crown, which is not seen in the illustration referred to, occupies a position by the side of, and usually a little posterior to, the central incisor crown. Its distal surface is contiguous to the mesial surface of the developing crown of the first premolar, one crypt wall being common to both these teeth at this period of their development. The developing crown of the canine, for which it is thus seen there is no room in the position it occupies in later life, lies at a much higher level than the crowns of the other teeth, its cusp being above the crypt wall that divides the permanent lateral from the first premolar. The floor of the crypt of this tooth is at a higher level than the floor of the nasal cavity, so that the mesial wall of the crypt forms part of the outer wall of the nasal cavity. The crowns of the upper premolars lie between the roots of their temporary predecessors. The crowns of the first permanent molars lie in their crypts just to the distal side of the second premolar, at the period to which this description applies, *i.e.*, about four and a half years. The first permanent molar crowns are not so advanced as those shown in the illustration to which reference has been made, in which it is seen that root formation has commenced and eruption has considerably advanced. The relationship of the permanent teeth at this age in the mandible somewhat resembles that of those in the upper jaw, excepting, of course, that the positions are reversed. That is to say, the crown of the developing canine in the mandible, is at a much lower level than those of the other permanent teeth, just as in the maxilla it is at a much higher level. Indeed, the proximity of the floor of the crypt, which contains the developing canine to the lower border of the mandible, is one of the most remarkable features of the lower jaw at this age.

One of the most interesting processes in the physiology of the teeth is that by which the roots of the first teeth are removed to make way for the advancing crowns of the permanent teeth. Unfortunately, the facts of naked eye anatomy do little to solve the problem which they themselves present. They serve, however, to controvert a theory that from time to time has been put forward by various dental writers, *i.e.* that the wasting of the roots of the temporary teeth is a direct result of the constant pressure of the erupting crowns of their successors. The anatomical facts are, moreover, in themselves sufficiently interesting, and, in view of the probability of theories being advanced to account for them, the student must note them with great care; as the best method of testing the accuracy of the theory of the would-be physiologist is to observe how far it agrees with, and can explain facts established by the accepted anatomist.

Resorption has been stated by recent writers to commence at the age of four years, but in the author's opinion it rarely if ever occurs earlier than five and a half years. As a rule the first tooth to show signs of it is the lower central incisor, and it will be convenient to trace the sequence of events as they present themselves in connection with that tooth.

In the majority of cases the apex of the root is the first to dissolve, although not infrequently resorption commences upon the lingual aspect of the root. When resorption begins at the apex, the root does not waste evenly, destruction of one side, as a rule the lingual, taking place more rapidly than elsewhere. The root is dissolved from without inwards ; that is to say, the cementum goes first, and then the most external layer of the dentine. After resorption has progressed beyond a certain point the appearance of the root of the tooth will sometimes seem to contradict this statement. For example, one occasionally finds an incisor tooth in which the labial wall of the root is less resorbed than any other part, and terminates in a sharp point. The reason of this is that decalcification has occurred first on the lingual wall and extended from without inwards, until the pulp was reached, and as the dentine immediately in contact with the pulp seems more resistent to resorption than the other parts, the mesial and distal walls are removed first, and the labial wall is thus left projecting.

When resorption has commenced in a temporary tooth the margins of the socket appear to embrace the neck of the tooth more closely than before ; so much so that a tooth in which the róot is almost resorbed to the level of the neck, seems more firmly held in position than others in which the process has not commenced.

The author has had no opportunity of observing the naked eye appearances of resorption in the human subject, as it has been impossible to obtain the necessary specimens for dissection ; but the following observations are based upon the appearances discernible by dissection of the young of certain of the lower animals, in which there is no reason for supposing that the phenomena differ in any essentials from those which we should discover by dissection of the human subject.

At the point at which resorption is about to commence, the dental periosteum becomes thickened, and in the injected specimen its vascularity is seen to be increased.

It is more easily separable from the root of the tooth over this spot than elsewhere. Very shortly afterwards the surface of the root becomes hollowed out. The extent of area over which this takes place is very variable. As a rule, when the resorption commences at or near the apex of the root, the extent of surface affected is very slight, but the depression in the root rapidly becomes well marked, having the appearance of being caused by the partial penetration of a small shot. This depression is filled by an ingrowth from the dental periosteum, and as the depression increases it maintains its circular outline, so that the vascular material that fills it soon assumes the shape of a small papilla. As this papilla approaches the pulp of the tooth the latter protects itself by the formation of new dentine, so that a tooth in which resorption has advanced well towards the pulp cavity, is found to have a more constricted pulp canal than its fellow, particularly if resorption has not commenced at all in the latter. The wasting of the root from this time onwards appears to be due to the invasion of this papilla. Except for the papilla no very large increase of the periosteal tissue takes place, for just as rapidly as the root dissolves, the socket is filled, usually by deposition of bone, more rarely by the advancing crown of the succeeding permanent tooth.

In the case of a molar tooth, resorption, as a rule, commences upon that aspect of the fang which is directed towards the crown of the premolar tooth which is to replace it. This normally lies between the roots of its temporary predecessor, so that in the case of an upper molar, resorption of the lingual fang commences on its buccal side, of the mesio-buccal fang on its disto-lingual aspect, and of the disto-buccal fang on its mesio-lingual aspect. In the case of a lower molar, resorption occurs first on the distal aspect of the mesial fang, and the mesial aspect of the distal fang. Resorption in the case of the molar teeth does not occur simultaneously in the fangs as a rule, one usually being resorbed considerably in advance of the other. Just as with the incisor teeth, resorption may occur near the apex, or may attack the side of the fang.

In the case of all the temporary teeth, resorption continues until the whole of the root is removed, and then, of course, the papilla which we may term the **resorption papilla** comes into direct contact with the remains of the pulp, which latter organ still retains its vitality, but appears to shrink as the papilla advances. It is not often that the temporary tooth remains in its place until the pulp entirely disappears, but the author has seen one or two cases in which this seems to have occurred, no visible remnant of pulp remaining when the crown of the tooth was removed. In these cases the dentine of the crown seems to have undergone resorption, and also the margins of the enamel; and when the crown was dried, from the thin edge of the enamel minute dust-like particles could be removed, which appeared to be enamel crystals. If this were so, it would seem that the resorption papilla has the power of disintegrating enamel without being capable of dissolving or absorbing it, as it appears to do in the case of the dentine and cementum.

When the crown of a tooth is removed, from which the roots are resorbed, if, as is usually the case, any of the pulp remain, it comes away with the crown of the tooth, the resorption papilla being left as a projection from the gum. If the removal is carefully effected and the surface previously occupied by the tooth crown dried, it will frequently be found that the only bleeding point is a minute spot at the apex of the resorption papilla. From this it seems evident that the pulp must be continuous with the resorption papilla at this point, and derives its blood supply through it.

The dates at which resorption of the various temporary teeth is complete roughly correspond, of course, with the dates of eruption of their permanent successors, because a temporary tooth is not normally shed until its successor is in a position to rapidly replace it. The author is of opinion that the process of resorption is much more rapid than one would infer from what has been written about it. It is a point which it is impossible to determine with certainty by inspection of dissected subjects; but one often finds in them a tooth which should normally be upon the point of being shed, with its root only very slightly resorbed. It could fairly be argued that in the case of specimens from human subjects who presumably died "from natural causes," the disease or disorder to which they succumbed would probably so seriously modify the process of resorption as to render the condition of the teeth a very untrustworthy criterion. The author has observed, however, the same condition in the case of lower animals, which, to his own knowledge, were quite healthy up to the day of their death. The point is one for the elucidation of which the employment of Röntgen-ray apparatus would be useful; but the author has been unable to find a suitable subject who would submit to the repeated examination that would be necessary. He ventures to predict that when a large number of cases have been investigated by this method, it will be found that in certain instances less than a month is necessary for the complete resorption of a fang.

Plate XI, Fig. B, very fairly represents the normal condition of the teeth at nine years of age, except that the root of the temporary lateral incisor does not appear to have undergone resorption, and its permanent successor has in consequence become somewhat deflected from its normal position. The illustration is the more interesting on that account, for it is the author's experience that the lateral incisor is more prone to resist resorption than any of the other temporary teeth.

Plate XII is a photograph of a specimen included in the anatomical series of the Museum of the Odontological Society of Great Britain. It is stated to be from a twelve-year-old subject. It is obviously pathological, and not at all typical of the teeth at that age. It is included here, as it illustrates better than a normal specimen would, the entire dependence of the alveolar processes upon the teeth, and shows how completely the sockets of the temporary teeth are removed when the teeth themselves are shed, and how the sockets of the permanent teeth are built up round them as they are extruded to their appointed places in the mouth.

At twelve years of age, in a normal specimen, all the temporary teeth have been removed, the premolars and canines being fully erupted, and the second molars are just making their appearance through the gum.

Plate XIII is a photograph of a specimen from a subject sixteen years old. All the permanent teeth are in place except the third molars. The student should note particularly the position of the lower third molar in relation to the inferior dental canal and the ramus of the mandible, as he will find it is a point of considerable importance in connection with the method of growth of the mandible, which is at present a moot question in dental physiology. With the eruption of the third molars the permanent dentition is completed, and the jaws arrive at the adult form shown in the specimen, of which *Plate V* is a photograph. This is an ideal specimen of the well-developed jaws of the European male adult.

PLATE XII

The following measurements are worthy of record. Of the mandible :—

Angle to condyle, $2\frac{19}{32}$ths inches.

Angle to symphysis, midway between genial tubercles, $2\frac{7}{8}$ inches.

Angle to angle, 4 inches.

The mental foramen is situated vertically beneath the second premolar, and exactly midway between the lower border of the mandible and the upper border of the external alveolar plate on the right side, but on the left side it is $\frac{1}{16}$th inch nearer the lower border. The depth of the body of the jaw at this point is exactly 1 inch. When the mandible is resting on a horizontal surface, the apex of the coronoid process rises $\frac{1}{16}$th inch above the condyle.

The angle formed by a line drawn from a point at the symphysis midway between the genial tubercles, to a point midway between the angles, with the line drawn from this latter point to a point mid-way between the condyles, is 117°.

The angle formed by the articulating surfaces of the condyle with a line drawn from condyle to condyle is 22°.

The distance from the contact point of the upper central incisors to the middle of the distal margins of the occlusal surfaces of the third molars, is $2\frac{5}{16}$ inches, and the distance between those points on the molars is $2\frac{3}{8}$ inches.

Of the teeth :—

The distance from the contact point of the lower central incisors to the middle points of the distal margins of the occlusal surfaces of the lower third molars, is $2\frac{1}{8}$ inches, while the distance between these points in the molars is $2\frac{3}{8}$ inches ; exactly the same as that between the corresponding upper teeth.

The gnathic index of the skull is 98·5, and its dental index is 43. It is therefore mesognathous and mesodont. These terms will be presently explained.

The skull of which measurements of the jaws and dental arches have been given, has been referred to as the ideal of the European type. It can scarcely be termed typical, as the average European would not be found to conform to it. Dental degeneration among civilized peoples is so rapidly progressive, and the variations from the ideal are consequently so many and so complex, that it is impossible to decide the exact form of the average

For the purposes of the text-book therefore, the ideal must be taken as the standard, to which the dental surgeon should endeavour, when circumstances require it, to make the variation as nearly as possible conform.

Exclusive of injuries and pathological changes, the only alteration in the external form of the crowns of the teeth after their formation, is that due to *attrition*. Of this all adult teeth show some indications, but the degree varies considerably with the individual. The lingual cusps of the upper, and the buccal cusps of the lower molars and premolars suffer most from this cause. As far as it is possible to judge from the accounts of the earlier dental writers, it would seem that the teeth suffer much less from attrition at the present day than was the case a century ago, but in the absence of statistics this is a difficult matter to decide with certainty.

Internally the teeth are undergoing constant change, the pulp cavities becoming smaller as age advances, so that not infrequently one finds them almost obliterated in the teeth of old people. The pulps, too, are very prone to give early indication of senile degeneration, but for the detection of this the microscope as a rule is necessary. Coincidently with this degeneration, the sockets of the teeth commence to atrophy, and finally the teeth loosen and are lost. The age at which this occurs varies considerably, but it is the author's experience, and that of the majority of his professional friends, that it is nearly a decade earlier in the present generation than it was in the last. It is not within the purpose of the present treatise to discuss the pathology of the dental pulp and its results, but since the teeth in the majority of cases are lost before the active period of life is over, a brief sketch of the anatomical changes that result is not out of place. In this connection the student's attention is directed to *Plate XIV*, which is from a

PLATE XIII.

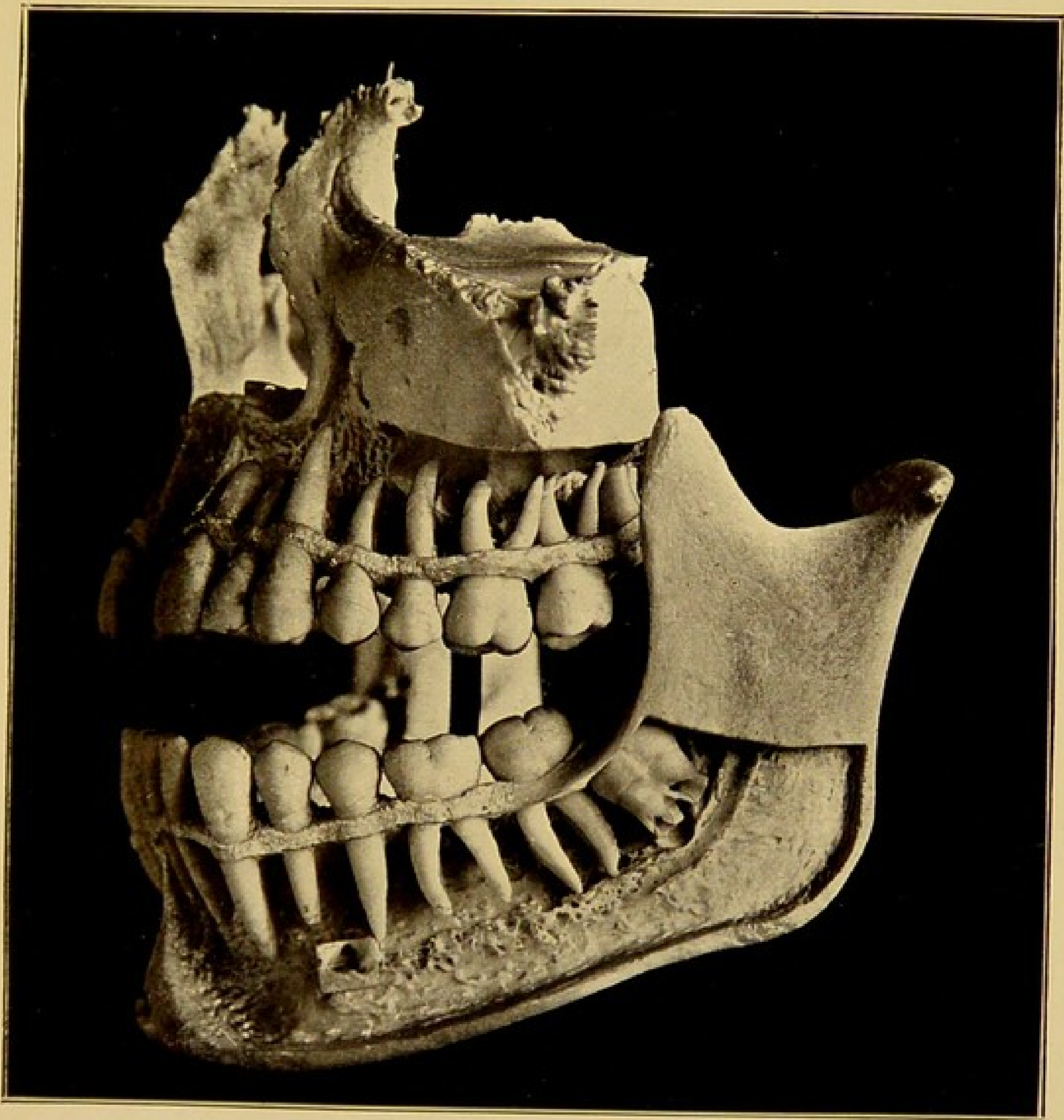
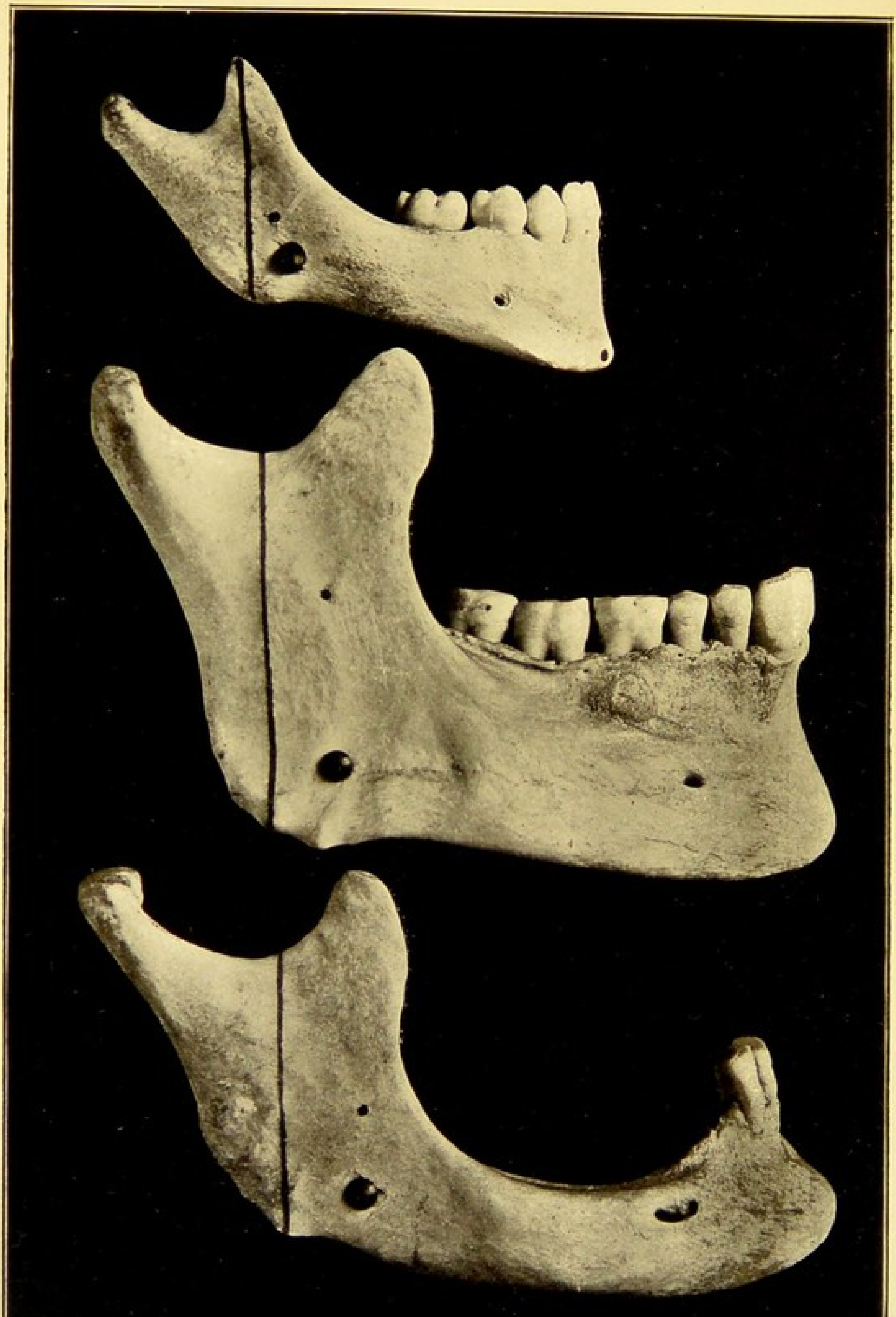


PLATE XIV.



photograph of three specimens showing the appearance of the mandible at three periods of life. The uppermost shows the mandible at the date of completion of the temporary dentition. Its comparison with that immediately below it, shows very clearly the changes in size and form which take place in the mandible when the permanent replaces the temporary dentition —changes which have been already described. The third specimen shows the changes which result from the loss of the teeth.

Of these changes, the most obvious and the first to take place is the atrophy or wasting of the alveolar portion, in which the missing teeth were originally embedded. The next change, which is also due to the loss of the teeth but less directly so, is the wasting of the angle, and, to a less degree, of the coronoid process. Later there is a considerable loss of substance from the body of the bone, chiefly from its lower border, but also from its surfaces, These changes are largely due to the fact that when the teeth are lost, the power of the elevator muscles is but seldom brought into play, and the bone wastes for the same reason that the bone of a limb wastes when its muscles are partly or completely paralysed. That this is so is evidenced by the fact that the wasting does not occur to nearly the same extent when the missing teeth have been replaced by properly adapted substitutes. John Hunter pointed out that when the teeth are lost, the mandible is rarely depressed to the same extent as when they are present for there is sufficient space for the introduction of food into the mouth, when the mandible is in the position in which the teeth would normally occlude. As the mandible is therefore rarely depressed, the elevator muscles undergo what Mr. Barwell has termed, in another connection, **contracture**. It is important to recognize this fact, because it has a very direct bearing upon certain points in dental pathology that have hitherto been misunderstood.

In the maxillæ the wasting of the alveolar portion is the most obvious change, because, as the bones take a passive part merely in the function of mastication, they are not so directly affected by the loss of the teeth, except in their alveolar portions. The glenoid cavities of the temporal bones become flattened, chiefly by the absorption of the eminences. This often gives the appearance of a relaxation of the ligaments, when in reality a shortening takes place.

Certain of the lower races of mankind differ markedly from the European, in that their dental arches occupy a more anterior position relatively to the skull. This condition, which is termed **prognathism**, is the consequence mainly of the greater prominence of the alveolar arches. For instance, a vertical line drawn downwards from the edge of the external alveolar plate of the mandible when that bone is resting on a horizontal surface, from a point between the central incisor teeth, would pass through the symphysis, and intersect the inner surface of the body of the bone, just above its lower border in the case of a typical European skull. In a typical Kaffir skull, a line drawn similarly is anterior to the body of the bone; the point from which it is drawn being anterior to the mental prominence. This prominence of the alveolar arches allows the teeth forming the lower dental arches to occupy a position relatively more anterior to the lower part of the body of the mandible. As a consequence of this, we find in the case of well marked prognathism that the mental foramen is situated beneath the first molar tooth, whereas its most usual position in the average European is beneath the septum, between the first and second premolars. The upper alveolar arch, of course, corresponds in position to the lower, and one result of this prominence is that there is ample room for the teeth. There are, indeed, recorded cases of the existence of an additional molar (fourth molar) at each extremity of the dental arches, and this without any overcrowding or irregularity of the teeth. This would of course be impossible in jaws of European type, in which there is rarely adequate space for the normal number of teeth.

Different methods of measuring the degree of prognathism have been suggested—the most generally accepted being that of Professor Flower. Taking BN as representing the distance between the middle of the anterior margin of the foramen magnum of the occipital bone and the middle of the fronto-nasal suture, and BA as the distance between the former point and the centre of the margin of the external plate of the upper alveolar ridge, he arrives at what he terms the gnathic index thus :—

$$\frac{BA \times 100}{BN} = \text{Gnathic Index.}$$

According to this method of classification, skulls with a gnathic index below 98 are orthognathous, from 98 to 103 mesognathous, and above 103 prognathous.

	GNATHIC INDEX.
English	96
Chinese	99
Eskimo	101
Fijian	103
Australian (aboriginal)	104

Flower, as a result of certain investigations, has also classified the races of mankind as *microdont*, *mesodont*, and *megadont*. This classification is very misleading; as it does not refer to the actual size of the teeth, as one would suppose, but to the relative length of the cranio-facial axis and dental arch, measured from the mesial margin of the occlusal surface of the first premolar to the distal margin of the occlusal surface of the third molar.

The cranio-facial axis, or basi-nasal line, is an imaginary line drawn from the middle of the anterior margin of the foramen magnum of the occipital bone, to the middle of the fronto-nasal suture.

Taking D as representing the length of the segment of the dental arch, and BN as the length of the cranio-facial axis, thus :—

$$\frac{D \times 100}{BN} = \text{Dental Index.}$$

According to this classification Australian races and Tasmanian aborigines are megadont; Negroes and Chinese mesodont; and Europeans microdont. The terms are extremely inapt, for skulls with actually small teeth sometimes come within the megadont class.

The periods at which the external form of the roots of the various teeth of the permanent set may be expected to be complete are shown in the following table :—

YEARS.	TEETH.
10.	The Upper and Lower First Molars and Lower Central Incisors
11.	The Upper Central, the Upper and Lower Lateral Incisors, and the Upper and Lower First Premolars
12.	The Upper and Lower Canines, and the Upper and Lower Second Premolars
17.	The Upper and Lower Second Molars
19.	The Upper and Lower Third Molars.

APPENDIX.

THE point in connection with the movements of the mandible, of most practical interest to the dental surgeon, is the direction of impact of the lower upon the upper teeth. If the temporo-mandibular joint acted as a simple hinge, as dental students in this country have been taught until quite recently, the direction of impact of any given occlusal point of the lower arch could be quite easily determined. For instance, a line drawn from the centre of the head of the condyle on one side, to the same point on the other, would represent the axis of movement of the mandible during simple depression and elevation. Another line drawn from the given occlusal point to the nearest point of the axial line, would be a radius of the arc described by the given point during the movement of depression and elevation. A line drawn through the given occlusal point in the plane of its arc of movement, at right angles to the radius, would indicate the direction of impact at any point in the arc. The direction of impact of the centre of the occlusal surface of the second lower molar of the average European skull would be 119 degrees from the horizontal, if the temporo-mandibular were really a hinge joint. Every time the lower teeth were brought into occlusion with the upper, the latter would be subjected to a protrusive thrust, which would tend to shift them to a more anterior position.

As a matter of fact, the direction of impact in a normal jaw is vertical. Unfortunately, a paper which I prepared, and contributed to a dental journal, has been lost under circumstances which it will serve no useful purpose to discuss here. This gave details of certain experiments which were carried out with the object of determining the path described by the lower teeth during elevation and depression of the mandible. The results may be summarised as follows. During simple elevation and depression, when no conscious effort is exercised in executing the movement, the mandible moves as if worked on an axis passing through the points of intersection of lines drawn vertically from the centre of the glenoid cavities, with a horizontal plane at the level of the occlusal surfaces of the lower first molar teeth. It should be remembered that it requires conscious effort to separate the dental arches further than usually takes place during ordinary movements of mastication, therefore beyond this point the movement of depression becomes more irregular. During elevation of the mandible, if the movement be resisted or very deliberately performed, protrusion of the mandible occurs. One result of this is that during mastication, particularly of food that requires effort, the impact of the lower premolar and molar teeth upon the upper is in a direction which tends slightly to retract the latter. This is brought about by a certain peculiarity in the action of the temporal muscle which has hitherto escaped notice. In the description of the muscles of mastication, the student will have noticed that the temporal muscle was described as a retractor rather than an elevator of the mandible. Now during elevation of the mandible the temporal muscle takes very little part in the production of the movement until it is almost complete. Consequently when tough food is being masticated the mandible is protruded, because the external pterygoid muscle is called into play to prevent the premature return of the condyle to the glenoid cavity. Just as the tips of the lower incisor teeth are about to engage with the upper, the temporal muscle acts forcibly, and draws the mandible upwards and backwards. It is thus obvious that not the least important action of the external pterygoid muscle is that which takes place during elevation of the mandible, and not the least important action of the temporal is that which retracts the mandible just at the moment when occlusion of the teeth is about to occur.

T. E. C.

INDEX.

JOHN WRIGHT AND CO., PRINTERS, STONE BRIDGE, BRISTOL.