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DENTAL ANATOMY

NOTE BOOK

DOUGLAS GABELL

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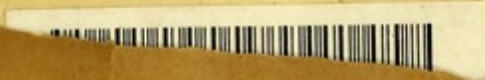
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DENTAL ANATOMY NOTE BOOK

*FOR USE IN CONJUNCTION WITH TOMES' "DENTAL ANATOMY,"
THE SOUTH KENSINGTON MUSEUM
AND
PERSONAL INSTRUCTION.*

BY

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LONDON :

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1900.

DENTAL ANATOMY
NOTE BOOK

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DENTAL ANATOMY.

PREFACE TO THE SECOND EDITION.

THE first edition of the DENTAL ANATOMY NOTE BOOK was no sooner published than it was sold; and, having since had numerous requests for copies, I have decided to amend and reprint it.

In spite of complaints as to its unwieldiness, I have kept to the original size, because I wish the book to remain essentially a "Note Book," the blank pages and the spaces in the text being left for diagrams and notes to be made by the student when reading up the subject of Dental Anatomy or being "coached."

The first part is practically Tomes' *Dental Anatomy* condensed, the second is intended as a guide to the study of the cases in the Central Hall of the South Kensington Museum, and the third is compiled from various sources.

All through the work an attempt has been made to tabulate concisely and to accentuate the principal points; details must, of course, be sought for in other books and in the examination of the actual specimens. The "How to show" and "Learn to recognise and explain" notes refer to microscope work, and are reminders to the student of *his* duty to a "Note Book."

DOUGLAS GABELL.

CHILTERN VILLA,
NEW BARNET.

November, 1900.

PREFACE TO THE SECOND EDITION.

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DENTAL ANATOMY.

TEETH are hard calcified or horny masses placed in or near the orifice of the alimentary canal, for the prehension or comminution of food.

The **FUNCTIONS** of teeth are:

PREHENSION	. . .	as in the Pike, &c.
COMMINUTION	. . .	Tiger, Elephant, &c.
COMBAT	. . .	Tiger, Pig, Narwal, &c.
Locomotion	. . .	Walrus.
Anchorage	. . .	Dinotherium.
Transport	. . .	Elephant.
Speech	. . .	Man.

ORIGIN AND HOMOLOGIES of the Teeth.

(**Homologous**.—Having like relations to a fundamental type; or, corresponding in type of structure.)

Read up a rough outline of **EMBRYOLOGY; EPIBLAST, MESOBLAST, and HYPOBLAST.**

The mouth is lined with **Epiblast.**

Note the similarity and continuity of the Placoid scales and teeth in a young dog-fish.

Note the similarity of fishes' teeth to mammalian teeth.

Therefore **Teeth** are **Homologous** with **Dermal Spines** both in origin and structure.

Teeth may be classified as

HORNY teeth, which consist of the hardened and thickened **Stratum Corneum** covering enlarged papillæ, and having an **Albuminous** matrix, and

CALCIFIED teeth, which consist of **Enamel, Dentine, and Cementum**, and have a matrix composed of **Collagen.**

Calcified teeth **ALWAYS** have an Enamel Organ even if no enamel is formed. Cementum only occurs on socketed or partially socketed teeth.

DENTAL ANATOMY.

TEETH are first formed in form of buds in the epithelium of the upper jaw, the lower jaw, and the palate.

The Functions of Teeth are:

FRAGMENTATION	of the food
TRITURATION	of the food
EXCRETION	of the food
Water	is taken up
Dissolution	of the food
Excretion	of the food
Saliva	is taken up

ORIGIN AND HOMOLOGUES of the Teeth.

(Homologous - having the same origin, but different form, as the eye and the leg.)

Teeth are homologous to the following structures:

- 1. The tooth is homologous to the epidermis.
- 2. The enamel is homologous to the epidermis.
- 3. The dentin is homologous to the connective tissue.
- 4. The pulp is homologous to the mesoderm.

Teeth are homologous to the following structures:

Teeth are homologous to the following structures:

HORNY MATTER which is found in the enamel and dentin is composed of keratin.

and is called the enamel and dentin.

CALCIFIED MATTER which is found in the enamel and dentin is composed of calcium phosphate.

Collagen

Teeth are ALWAYS found in pairs, one in the upper jaw and one in the lower jaw.

of which are called the upper and lower teeth.

ENAMEL

Is very hard, brittle, bluish-white, and semi-translucent.
And composed of **Calcified Prisms** in a **Calcified Matrix**.

CHEMICAL COMPOSITION.

Organic Matter,	(mucin?)	NONE.			
Salts,	{ CALCIUM PHOSPHATE Calcium carbonate Calcium fluoride Magnesium phosphate }	95 %			
			Water,	(chemically combined with the salts)	5 %

THE MATRIX

Is very small in amount, absolutely calcified, but is more easily dissolved by acids than the prisms.

THE PRISMS

Are long hexagonal varicose rods, solid, and absolutely calcified, but the centre is usually more easily dissolved by acids than the external part.

In the Eel	No structure is visible.
Manatee	Straight prisms.
Sciuridæ	Lamellate thus:—
Beaver	Lamellate and flexuous prisms thus:—
Porcupine	Lamellate and spiral prisms.
Leporidæ	No lamellæ, only flexuous prisms.
Muridæ	Serrated prisms.
Man	Straight or slightly flexuous prisms.

The **Transverse Striæ** of prisms are due to either:—
 1. Varicosity of the prisms.
 2. Intermittent calcification.
 3. Decussation of the prisms.
 4. Boedecker's "thorns."
 or 5. The action of acids (balsam).

In all **Marsupials** (bar the **Wombat**), some **Rodents** (**Jerboa**), some **Insectivora** (**Soricidæ**), **Hyrax**, and some **Fishes** (**Barbel**, **Porbeagle Shark**), the central portions of the prisms remain **Uncalcified**, *i.e.*, **Tubular Enamel**.

Sometimes this happens at the inner parts of the enamel only, sometimes at the outer part (**Sargus**); often this condition is irregularly distributed.

LEARN TO RECOGNISE and explain:—

- "BROWN STRIÆ OF RETZIUS."
- "SCHREGER'S LINES."
- "TOMES' LINES."
- "BOEDECKER'S THORNS."
- "PIGMENT IN THE ENAMEL."
- "IRREGULAR FISSURES NEAR THE DENTINE."

DISTRIBUTION OF ENAMEL.

Absent from	Edentata, Narwal, some Cetacians, Reptiles, and Fish.
Tip only in	Hake, Eel, Elephant's tusk.
All over crown in	Man and most Mammalia.
Front or sides only of tooth in	} Rodents' incisors. } Canines of Suinæ, Iguanodon.

LEARN HOW TO SHOW:—

ENAMEL PRISMS, TRANSVERSE STRIÆ, STRIÆ OF RETZIUS, SCHREGER'S LINES.

ENAMEL

is very hard, tough, translucent, and heat resistant. As a compound of calcium fluoride in a calcium matrix.

CHEMICAL COMPOSITION

Component	Percentage
Calcium fluoride	96.3%
Calcium hydroxide	3.7%

THE MATRIX

is very hard, tough, translucent, and heat resistant, but is more easily dissolved by acids than the prisms.

THE PRISMS

are very hard, tough, translucent, and heat resistant, but are more easily dissolved by acids than the matrix.

Prism Type	Composition
Prism A	Calcium fluoride, Calcium hydroxide
Prism B	Calcium fluoride, Calcium hydroxide, Magnesium fluoride
Prism C	Calcium fluoride, Calcium hydroxide, Magnesium fluoride, Strontium fluoride

1. The prisms are of various sizes and shapes.
2. The prisms are arranged in a regular pattern.
3. The prisms are embedded in a matrix.
4. The prisms are separated by a thin layer of matrix.

The prisms are of various sizes and shapes, and are arranged in a regular pattern. They are embedded in a matrix, and are separated by a thin layer of matrix.

The prisms are of various sizes and shapes, and are arranged in a regular pattern. They are embedded in a matrix, and are separated by a thin layer of matrix.

LEARN TO RECOGNIZE THE PRISMS

1. The prisms are of various sizes and shapes.
2. The prisms are arranged in a regular pattern.
3. The prisms are embedded in a matrix.
4. The prisms are separated by a thin layer of matrix.

DISTRIBUTION OF ENAMEL

The enamel is distributed in a regular pattern. The prisms are embedded in a matrix, and are separated by a thin layer of matrix.

LEARN HOW TO SHOW

ENAMEL PRISMS THROUGH STAIN OF RETICULAR SUBSTRUCTURE LAYER

DENTINE.

Varieties.

Hard (unvascular), Plici-dentine, Vaso-dentine, and Osteo-dentine.

Hard Dentine

Is hard, elastic, yellowish and semi-translucent, and composed of a **Calcified Matrix**, permeated by **Tubes** containing **Fibrils**.

CHEMICAL COMPOSITION (dried dentine).

Organic matter,	<table> <tr> <td>Collagen</td> <td rowspan="2">}</td> <td rowspan="2">.</td> <td rowspan="2">20 %</td> </tr> <tr> <td>Elastin</td> </tr> </table>	Collagen	}	20 %	Elastin		
Collagen	}				20 %		
Elastin								
Salts,	<table> <tr> <td>CALCIUM PHOSPHATE</td> <td rowspan="4">}</td> <td rowspan="4">.</td> <td rowspan="4">72 %</td> </tr> <tr> <td>Calcium carbonate</td> </tr> <tr> <td>Calcium fluoride</td> </tr> <tr> <td>Magnesium phosphate</td> </tr> </table>	CALCIUM PHOSPHATE	}	72 %	Calcium carbonate	Calcium fluoride	Magnesium phosphate
CALCIUM PHOSPHATE	}				72 %		
Calcium carbonate								
Calcium fluoride								
Magnesium phosphate								
Water,	(chemically combined with salts) 8 %							
FRESH dentine also contains 10 % of FREE water.								

THE MATRIX

Is collagen impregnated with salts. When decalcified a very faint fibrous structure is apparent.

THE TUBES (Sheaths of Neumann)

Run at right angles to the surface of the pulp, and
 Decrease in diameter as they near the periphery;
 Those at the neck of the tooth have a large flexuous **Primary Curve**,
 Those in the root have many small spiral **Secondary Curves**.
 Many little lateral branches are given off, and
 The tubes terminate:—In forked extremities,
 in loops with each other,
 in the granular layer,
 in fissures in the enamel,
 or by anastomosing with the canaliculi in the cementum.

The tubes are said to be composed of **Elastin** and lime salts, and resist the action of acids and alkalies.

THE FIBRILS

Are soft, sentient, branched processes of the odontoblasts.
Proofs = stretching and contraction. **Functions** are nutritive and sentient.

LEARN TO RECOGNISE and explain:—

- "SCHREGER'S LINES."
- "OWEN'S LINES."
- "INTERGLOBULAR SPACES."
- "GRANULAR LAYER OF TOMES."

LEARN HOW TO SHOW:—

OWEN'S LINES, INTERGLOBULAR SPACES, SCHREGER'S LINES, GRANULAR LAYER, SHEATH OF NEUMANN, DENTINAL FIBRIL, FIBROUS MATRIX.

DENTINE

Varieties

Hard dentine, Pseudo-dentine, Vaso-dentine, and Osteo-dentine.

Hard Dentine

It is the most abundant and well-developed and composed of a calcium salt, phosphate of lime, and organic matter.

CHEMICAL COMPOSITION (Hard Dentine)

Organic matter	Collagen	1.0%
	Elastic	0.5%
Salt	Organic phosphate	13.0%
	Calcium carbonate	
	Calcium fluoride	
Water	Hydroxyapatite	85.5%

THE MATRIX

It is composed of organic matter and water. When saturated with water, it is very soft and elastic.

THE TUBES (Canals in Dentine)

They are small tubes in the dentine, the walls of which are composed of dentine. They are filled with dentinal fluid and are lined with a layer of dentin. They are the result of the downward growth of dentin from the pulp chamber.

THE FIBRILS

They are the fine threads of dentin which form the matrix of the dentine. They are composed of collagen and elastic fibers.

LEARN TO RECOGNISE THE TUBES

- 1. Tubular layer
- 2. Owen's lines
- 3. Interglobular spaces
- 4. Granular layer of Tome

LEARN HOW TO SHOW

Owen's lines, interglobular spaces, Tomes' granular layer, sheath of dentin, dentinal fluid, porous matrix.

Plici-Dentine.

The pulp is more or less folded. No cementum intervenes.

Varanus, **Lepidosteus Oxyurus**, **Lepidosteus Spatula**, **Labyrinthodon**, **Myliobates**, **Orycteropus** (Cape Ant-eater), and **Pristis** (dermal spines).

The last three might be regarded as fused simple teeth.

Vaso-Dentine.

The dentinal tubes and fibrils are replaced by **Canals** containing **Capillary** blood-vessels.

The **Matrix** is often laminated (also "thorns"), and in its outer part a fibrous structure is often visible.

Vaso-Dentine is softer than hard dentine.

In the **Hake**, **Chætodonts**, and **Ostracion** there are no dentinal fibrils.

In the **Flounder**, **Megatherium**, **Iguanodon**, **Odontostomus**, and **Haddock** there are both capillaries and fibrils.

In the **Lotella** there are neither.

Sargus and **Manatee** show the remains of a vascular system.

Vascular canals are rarely found in **Human** dentine.

Osteo-Dentine.

Calcification takes place in the substance of, as well as on the surface of, the pulp.

There is usually an outer layer of fine tube dentine, then irregular trabeculæ of dentine containing **Canaliculi** and sometimes **Lacunæ**, and between the trabeculæ are spaces filled with pulp tissue and lined with flattened cells;

Pike and **Lamna**.

NOTE THE GRADATIONS BETWEEN

HARD, PLICI-, VASO- (BOTH SORTS), OSTEO-DENTINE AND BONE.

Secondary Dentine

May be of any of the varieties above mentioned, or structureless, or irregular.

It occurs very readily in **Elephants'** tusks and **Whales'** teeth,

And normally in the pulps of **Persistent** growing teeth;

Also in any pulp as a **Pathological** condition.

LEARN HOW TO SHOW:—

PLICI-, VASO-, OR OSTEO-DENTINES. (a) WITH; (b) WITHOUT SOFT PARTS.

Pitch-Denture

The pitch is given in the table. It is the same as the pitch of the denture. The pitch is given in the table. It is the same as the pitch of the denture. The pitch is given in the table. It is the same as the pitch of the denture.

Vase-Denture

The vase denture is a denture which is made of a material which is called vase. The vase denture is a denture which is made of a material which is called vase. The vase denture is a denture which is made of a material which is called vase. The vase denture is a denture which is made of a material which is called vase.

Osteo-Denture

The osteo denture is a denture which is made of a material which is called osteo. The osteo denture is a denture which is made of a material which is called osteo. The osteo denture is a denture which is made of a material which is called osteo. The osteo denture is a denture which is made of a material which is called osteo.

NOTE THE GRADATIONS BETWEEN

READ ALSO WITH OTHER OSTEO-DENTURE AND VASE

Secondary Denture

The secondary denture is a denture which is made of a material which is called secondary. The secondary denture is a denture which is made of a material which is called secondary. The secondary denture is a denture which is made of a material which is called secondary. The secondary denture is a denture which is made of a material which is called secondary.

LEARN HOW TO SHOW

READ ALSO ON OSTEO-DENTURE WITH WITHOUT FOOT PACE

PULP.

Composed of **Matrix, Cells, Fibrous Tissue, Vessels and Nerves.**

FUNCTIONS.

Formative ; Nutritive ; Nervous.

THE MATRIX

Is plentiful, soft and jelly-like.

THE CELLS.

The **central** cells are numerous and have fine processes.

The odontoblasts (*membrana eboris*) form a complete surface layer ; they are large elongated granular cells and send out processes: 1, into the **Dentine** (dentinal fibril), 2, **laterally**, and 3, towards the **pulp**.

In old age the odontoblasts become smaller and more oval.

THE VESSELS.

Arteries, capillaries, veins, and **no** lymphatics.

THE NERVES.

Three or four medullated nerves, which soon lose their sheaths and form a plexus near the surface of the pulp (plexus of Raschkow). The nerves probably terminate as fine varicose filaments between the odontoblast cells. Other views are that they join the dentinal fibrils, or run with them, or that they join the pulp processes of the odontoblasts.

THE FIBROUS TISSUE

Is very faint and continuous with that in the matrix of the dentine.

In old age it increases and the cells disappear.

LEARN TO RECOGNISE and explain :—

"BASAL LAYER OF WEIL."

"ODONTOBLASTS."

LEARN HOW TO SHOW :—

ODONTOBLASTS, PULP TISSUE IN SITU, NERVE TRUNKS, NERVE ENDINGS.

PULP

Composed of Dentin, Cells, Fibrous Tissue, Vessels and Nerves.

FUNCTIONS

Protective; Nutritive; Nervous

THE MATRIX

Is plastic, soft and jelly-like.

THE CELLS

The central cells are numerous and have fine processes.

The odontoblasts (marginated spines) form a complete surface layer; they are large elongated spindle cells and send out processes: 1. into the Dentin (dentiniferous), 2. laterally, and 3. towards the pulp.

In old age the odontoblasts become smaller and more oval.

THE VESSELS

Arteries, capillaries, veins, and no lymphatics.

THE NERVES

There is one medullated nerve, which runs down their length and form a plexus near the surface of the pulp chamber of the tooth. The nerve probably terminates in fine varicose filaments between the odontoblast cells. Other views are that they join the dentinal fibrils or run with them or that they form the pulp processes of the odontoblasts.

THE FIBROUS TISSUE

Is very fine and continuous with that in the matrix of the dentin. In old age it becomes and the cells disappear.

LEARN TO RECOGNISE and explain

"BASAL LAYER OF WELL-
"ODONTOBLASTS"

LEARN HOW TO SHOW

ODONTOBLASTS, PULP TISSUE IN SITU, NERVE TRUNKS, NERVE ENDINGS

CEMENTUM

Consists of a **Calcified Matrix** containing **Lacunæ**, **Canaliculi** and sometimes blood-vessels.

CHEMICAL COMPOSITION.

Almost the same as bone.

THE MATRIX,

If thin, is **structureless** or granular.

If thick it is **laminated** and contains **lacunæ**.

LEARN TO RECOGNISE and explain:—

"SHARPEY'S FIBRES."

"INTERCREMENTAL LINES OF SALTER."

THE LACUNÆ

Are not usually present in thin cementum.

They are more irregular in size and shape than bone lacunæ.

The **Canaliculi** are abundant, especially towards the surface.

Each lacunæ is filled with a **Cement Corpuscle**.

LEARN TO RECOGNISE and explain:—

"ENCAPSULED LACUNÆ."

THE BLOOD VESSELS

Occur in thick cementum only, and do not form Haversian systems.

DISTRIBUTION.

Cementum is rare in Fishes and Reptiles.

It covers the roots in all Mammalia teeth and the crowns of some.

It is the **most external** dental tissue.

LEARN HOW TO SHOW:—

SHARPEY'S FIBRES, INTERCREMENTAL LINES OF SALTER, LACUNÆ AND ENCAPSULED LACUNÆ.

NASMYTH'S MEMBRANE

Is a thin layer of **Hardened Epithelial Cells** (derived from the enamel organ), covering the enamel, and having on its inner surface a thin, structureless membrane.

LEARN HOW TO SHOW:—

NASMYTH'S MEMBRANE IN SITU, also its **STRUCTURE**.

CEMENTUM

Consists of a Gelatin Matrix containing Lactin, Casein and sometimes blood vessels

CHEMICAL COMPOSITION

Shows the ratio as follows

THE MATRIX

If this is represented as granular
It may be laminated and contains lacunae

LEARN TO RECOGNISE and explain

"SHARPEY'S FIBRE"
"INTERDENTAL LINES OF SALTER"

THE LACUNAE

Are not usually present in thin cementum
They are more present in the root than the crown
The lacunae are abundant especially towards the surface
Each lacuna is filled with a Cement Crystallite

LEARN TO RECOGNISE and explain

"ENCRUSTED LACUNAE"

THE BLOOD VESSELS

Occur in thick cementum only and in the form of a vascular system

DISTRIBUTION

Distribution is not in Epithelium and Dentine
It covers the roots in all mammals teeth and the crown of some
It is the most external dental tissue

LEARN HOW TO SHOW

"SHARPEY'S FIBRE INTERDENTAL LINES OF SALTER LACUNAE AND ENCRUSTED LACUNAE"

NASMYTH'S MEMBRANE

Is a thin layer of hardened epithelial cells derived from the enamel organ covering the enamel and
forming an in situ surface a thin, translucent membrane

LEARN HOW TO SHOW

"NASMYTH'S MEMBRANE IN SITU AND IN STRUCTURE"

GUM

Is composed of **Stratified Epithelium** covering broad **Papillæ**, which contain numerous **Blood-Vessels** and a few **Nerves**, bound together by much **FIRM Fibrous Tissue**, the latter blending with the periosteum of the alveolus.

It is hard, dense, firmly adhered to the bone, very vascular and only slightly sentient.

LEARN TO RECOGNISE and explain:—

"GLANDS OF SERRES."

"POCKETS" ROUND THE TEETH.

"HEALTH LINE."

LEARN HOW TO SHOW:—

GUM IN SITU, NERVES, GLANDS OF SERRES.

ALVEOLO-DENTAL MEMBRANE

Is composed of bundles of **White Fibrous Tissue** containing **Blood-Vessels**, **Nerves** and **Cells** between the meshes.

It serves to fix the teeth, to prevent shock and damage to the nerves, and to nourish the cementum.

THE FIBRES

Are non-elastic and run **obliquely** from the bone to the tooth.

The ends of these fibres become imbedded in the hard tissues to form

"SHARPEY'S FIBRES."

THE BLOOD VESSELS

Are very numerous and derived from the bone, gum and apical vessels.

They form a capillary net-work close to the cementum.

Lymphatics are plentiful and most visible near the apex.

THE NERVES

Are derived from the bone and apical nerves and render the membrane **HIGHLY** sensitive.

THE CELLS

Are found between the fibres, especially near the cementum (osteoblasts).

Nests of Epithelial cells are also often found, which are remnants of the **Epithelial Sheath of Hertwig**, and form the so-called

"GLANDS OF SERRES."

The alveolo-dental membrane is thickest near the neck and apex. In old age it becomes thinner.

LEARN HOW TO SHOW:—

PERIOSTEUM IN SITU, GLANDS OF SERRES, BLOOD-VESSELS.

is composed of stratified epithelium covering fused papillae which contain numerous blood-vessels and a few
nerves bound together by much firm fibrous tissue, the latter blending with the peristomium of the
It is best shown freely adhered to the bone, very vascular and only slightly calcified.

LEARN TO RECOGNISE and explain:

- "GLANDS OF SERRES"
- "ROCKETS" ROUND THE TEETH
- "HEALTH LINE"

LEARN HOW TO SHOW:

GUM IN SITU, NERVES, GLANDS OF SERRES

ALVEOLO-DENTAL MEMBRANE

is composed of bundles of white fibrous tissue containing blood-vessels, nerves and cells between the
It serves to fit the teeth to prevent shock and damage to the nerves and to furnish the connection

THE FIBRES

are elastic and run obliquely from the bone to the teeth.
The ends of these fibres become embedded in the hard tissues to form
"SHARPEY'S FIBRES"

THE BLOOD VESSELS

are very numerous and derived from the bone, gum and dental vessels.
They form a capillary net-work close to the connection
Composites are plentiful and most visible near the apex.

THE NERVES

are derived from the gum and dental nerves and render the membrane highly sensitive.

THE CELLS

are found between the fibres, especially near the connection (osteoblasts).
Many of epithelial cells are also often found, which are remnants of the epithelial growth of the gum
and form the so-called

"GLANDS OF SERRES"

The alveolo-dental membrane is thickest near the root and apex. As old age it becomes thinner.

LEARN HOW TO SHOW:

PERISTOMIUM IN SITU, GLANDS OF SERRES, BLOOD VESSELS

DEVELOPMENT OF THE TEETH.

IN FISH.

In the Elasmobranch fish there is a continuous growing **tooth band**, **enamel buds**, and **dentine papillæ**, but no follicle, and the enamel organ is very simple in structure.

In Teleost fish there is no tooth band or follicle, and each simple **enamel bud** and **dentine papilla** is developed *de novo*.

IN REPTILES

There is a continuous growing **tooth band**, **enamel buds**, and **dentine papillæ**, the whole being enclosed in a fibrous sac, a sort of common follicle, forming the "**area of tooth development**."

IN MAMMALIA (*e.g.*, Human)

There is a **tooth band** of limited growth, only two sets of **enamel buds** and **dentine papillæ**, each pair having its own **follicle**.

Confining our description for convenience to the lower jaw, at the:—

6th week

An ingrowth of epithelium occurs all round the margin of the jaw.

7th week

This ingrowth divides into two bands, an outer vertical "**labio-dental strand**" (lippenfurche), and an inner more horizontal "**dental lamina**" (zahnleiste), and a groove "**dental furrow**" appears at the origin of the latter from the surface. Calcification of the bone starts.

9th week

Ten enlargements, "**enamel buds**," appear near the free end of the dental lamina.

10th week

Eight thickenings of the mesoblast appear against the under surface of the enamel buds "**dentine papillæ**." The enamel buds have become club shaped.

11½th week

Two more dentine papillæ appear, *i.e.*, ten "**tooth germs**" are now formed.

The central cells of the lippenfurche atrophy to form the labio-dental sulcus.

14th week

The enamel buds for the incisors develop into "**enamel organs**." The bone commences to grow up round the developing teeth. The dental lamina extends backwards free from the gum.

17th week

Another enamel bud (for the six-year old molar) appears with its corresponding dentine papilla. The dental lamina is beginning to **become fenestrated** at the front of the mouth.

20th week

Calcification starts in the **milk incisors**.

24th week

Enamel buds and dentine papillæ for the permanent incisors and canines appear. Calcification commences in the temporary canines and molars.

29th week

The enamel bud for the 1st bicuspid appears.

33rd week

The enamel bud for the 2nd bicuspid appears.

AT BIRTH

The dental lamina is cribriform in front, but whole at the back of the mouth.

The necks of the enamel organs of the incisors have gone, those of the molars are whole.

The teeth are calcified thus:—

The germs of the permanent incisors and canines are visible to the naked eye, those of the bicuspids and 2nd and 3rd molars are not yet visible.

The crypts are incomplete and the permanent and temporary teeth are in a common locus.

DEVELOPMENT OF THE TEETH

IN FISH

In the teleosts there is a continuous growing tooth band, enamel buds, and dentine papillae but no follicle and the enamel organ is very simple in structure. In teleosts there is no tooth band or follicle and each simple enamel bud and dentine papilla is developed in situ.

IN REPTILES

There is a continuous growing tooth band, enamel buds, and dentine papillae, the whole being enclosed in a follicle and a part of enamel follicle, forming the "axis of tooth development".

IN MAMMALIA (e.g. Human)

There is a tooth band of limited growth, only two sets of enamel buds and dentine papillae, each pair having its own follicle. Comparing our description for comparison to the lower jaw, at the:

8th week

An epithelium occurs all round the margin of the jaw.

10th week

The epithelium divides into two bands, an outer vertical "labio-dental strand" (lip-denture) and an inner horizontal "dental lamina" (denture), and a groove "dental furrow" appears at the origin of the latter from the surface. Composition of the bone starts.

12th week

The development "enamel buds" appear near the jaw and of the dental lamina.

14th week

Light dentin of the mesial aspect against the outer surface of the enamel buds "dentine papillae". The enamel buds become club shaped.

16th week

Two more dentine papillae appear, one for "tooth germ" are now formed. The central cells of the epithelium multiply to form the labio-dental sulcus.

18th week

The enamel buds for the molars develop into "enamel organs". The bone commences to grow up round the developing teeth. The dental lamina extends backwards from the gum.

20th week

Enamel buds for the six year old teeth appear with its corresponding dentine papillae. The dental lamina is beginning to become interrupted at the front of the mouth.

22nd week

Calcification starts in the milk teeth.

24th week

Enamel buds and dentine papillae for the permanent incisors and canines appear. Calcification commences in the temporary incisors and molars.

26th week

The enamel buds for the incisors appear.

28th week

The enamel buds for the molars appear.

AT BIRTH

The dental lamina is continuous in front but ends at the back of the mouth. The buds of the enamel organs of the incisors have gone, those of the molars are visible. The teeth are embedded thus:— The germs of the permanent incisors and canines are visible in the nasal eye, those of the temporary incisors and molars are not yet visible. The eruptive are incomplete and the permanent and temporary buds are in a common lamina.

TEMPORARY DENTITION.

	CENTRAL.	LATERAL.	CANINE.	1st MOLAR.	2nd MOLAR.
Enamel buds appear	9th week.	9th week.	9th week.	9th week.	9th week.
Calcification starts	20th week.	20th week.	20th week.	24th week.	24th week.
Condition at birth	1 (crown).	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{2}$
Eruption occurs	6th month.	9th month.	18th month.	14th month.	26th month.
Calcification ends	3rd year.	3 $\frac{1}{2}$ th year.	4 $\frac{1}{2}$ th year.	5th year.	6th year.
Absorption starts	4th year.	5th year.	9th year.	7th year.	8th year.

PERMANENT DENTITION.

	C.	L.	C.	B ₁ .	B ₂ .	M ₁ .	M ₂ .	M ₃ .
Enamel bud appears	24th wk.	24th wk.	24th wk.	29th wk.	33rd wk.	17th wk.	4th mth.	3rd yr.
Calcification starts	1st mth.	2nd mth.	6th mth.	1 $\frac{1}{2}$ th yr.	2nd yr.	At birth.	2nd yr.	12th yr.
Condition at 6 years	1 (crown).	$\frac{2}{3}$	1	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{4}$ (root).	$\frac{1}{3}$ (crown).	—
Eruption occurs	7th yr.	8th yr.	11th yr.	10th yr.	11th yr.	7th yr.	13th yr.	24th yr.
Calcification ends	10th yr.	10th yr.	11th yr.	13th yr.	13th yr.	9th yr.	16th yr.	?

ENAMEL ORGAN.

The enamel bud is composed of cubical epithelial cells, and is at first only a thickening of the lower end of the tooth band; it then becomes club shaped, and then bell shaped, growing out on the **Labial** side of the tooth band. Next as it increases in size and encloses the dentine papilla it becomes differentiated into four layers: the **External Epithelium**, composed of oval cells; the **Stellate Reticulum**, composed of stellate cells; the **Stratum Intermedium**, composed of one or two layers of oval cells; and the **Internal Epithelium**, composed of large, long, granular, columnar cells with the nucleus at the outer end.

The functions of the:—

- Internal epithelium** (ameloblasts) is to form enamel,
- Stratum intermedium** is to recruit the internal epithelium,
- Stellate reticulum** is to act as a packing material,
- External epithelium** is to form Nasmyth's membrane.

The enamel organ only becomes thus specialised where it is going to produce enamel. It is continued on as a thin layer of oval cells so as to invest the whole of the roots of the tooth; this continuation is called the "**Epithelial Sheath of Hertwig.**"

DENTINE PAPILLA.

The dentine papilla is at first only a thickening of the mesoblast in front of the enamel bud, but presently the surface cells develop into columnar cells (odontoblasts), smaller and less regular than the ameloblasts, but still well marked off from the underlying round cells of the rest of the papilla, which is well supplied with blood vessels and nerves.

DENTAL FOLLICLE or sac.

The follicle at first appears as a thickening of the mesoblast cells outside the enamel organ and continuous below with the dentine papilla. At first it is composed of very loosely packed cells, but later on it becomes differentiated into an outer firm fibrous layer and an inner very vascular more cellular layer; little processes from the latter project into the enamel organ a short way. The **functions** of the outer layer are to protect the developing tooth and later on to form the dental periosteum, those of the inner layer are to nourish the enamel organ and eventually to form the cementum.

When a very thick layer of cementum has to be formed the inner layer of the follicle becomes **cartilaginous** before calcification takes place, this cartilage is called the "**Cement organ.**"

A **small foramen** exists behind the necks of the temporary teeth for the transmission of a small artery and a little fibrous tissue from the gum to the follicle of the permanent tooth.

TEMPORARY DENTITION

ENAMEL END APPEARS	ERUPTION BEGINS	ERUPTION COMPLETE	EXFOLIATION BEGINS	EXFOLIATION COMPLETE
10th week	10th week	10th week	10th week	10th week
12th week	12th week	12th week	12th week	12th week
14th week	14th week	14th week	14th week	14th week
16th week	16th week	16th week	16th week	16th week
18th week	18th week	18th week	18th week	18th week
20th week	20th week	20th week	20th week	20th week
22nd week	22nd week	22nd week	22nd week	22nd week
24th week	24th week	24th week	24th week	24th week
26th week	26th week	26th week	26th week	26th week
28th week	28th week	28th week	28th week	28th week
30th week	30th week	30th week	30th week	30th week
32nd week	32nd week	32nd week	32nd week	32nd week
34th week	34th week	34th week	34th week	34th week
36th week	36th week	36th week	36th week	36th week
38th week	38th week	38th week	38th week	38th week
40th week	40th week	40th week	40th week	40th week
42nd week	42nd week	42nd week	42nd week	42nd week
44th week	44th week	44th week	44th week	44th week
46th week	46th week	46th week	46th week	46th week
48th week	48th week	48th week	48th week	48th week
50th week	50th week	50th week	50th week	50th week
52nd week	52nd week	52nd week	52nd week	52nd week
54th week	54th week	54th week	54th week	54th week
56th week	56th week	56th week	56th week	56th week
58th week	58th week	58th week	58th week	58th week
60th week	60th week	60th week	60th week	60th week
62nd week	62nd week	62nd week	62nd week	62nd week
64th week	64th week	64th week	64th week	64th week
66th week	66th week	66th week	66th week	66th week
68th week	68th week	68th week	68th week	68th week
70th week	70th week	70th week	70th week	70th week
72nd week	72nd week	72nd week	72nd week	72nd week
74th week	74th week	74th week	74th week	74th week
76th week	76th week	76th week	76th week	76th week
78th week	78th week	78th week	78th week	78th week
80th week	80th week	80th week	80th week	80th week
82nd week	82nd week	82nd week	82nd week	82nd week
84th week	84th week	84th week	84th week	84th week
86th week	86th week	86th week	86th week	86th week
88th week	88th week	88th week	88th week	88th week
90th week	90th week	90th week	90th week	90th week
92nd week	92nd week	92nd week	92nd week	92nd week
94th week	94th week	94th week	94th week	94th week
96th week	96th week	96th week	96th week	96th week
98th week	98th week	98th week	98th week	98th week
100th week	100th week	100th week	100th week	100th week

PERMANENT DENTITION

ENAMEL END APPEARS	ERUPTION BEGINS	ERUPTION COMPLETE	EXFOLIATION BEGINS	EXFOLIATION COMPLETE
10th week	10th week	10th week	10th week	10th week
12th week	12th week	12th week	12th week	12th week
14th week	14th week	14th week	14th week	14th week
16th week	16th week	16th week	16th week	16th week
18th week	18th week	18th week	18th week	18th week
20th week	20th week	20th week	20th week	20th week
22nd week	22nd week	22nd week	22nd week	22nd week
24th week	24th week	24th week	24th week	24th week
26th week	26th week	26th week	26th week	26th week
28th week	28th week	28th week	28th week	28th week
30th week	30th week	30th week	30th week	30th week
32nd week	32nd week	32nd week	32nd week	32nd week
34th week	34th week	34th week	34th week	34th week
36th week	36th week	36th week	36th week	36th week
38th week	38th week	38th week	38th week	38th week
40th week	40th week	40th week	40th week	40th week
42nd week	42nd week	42nd week	42nd week	42nd week
44th week	44th week	44th week	44th week	44th week
46th week	46th week	46th week	46th week	46th week
48th week	48th week	48th week	48th week	48th week
50th week	50th week	50th week	50th week	50th week
52nd week	52nd week	52nd week	52nd week	52nd week
54th week	54th week	54th week	54th week	54th week
56th week	56th week	56th week	56th week	56th week
58th week	58th week	58th week	58th week	58th week
60th week	60th week	60th week	60th week	60th week
62nd week	62nd week	62nd week	62nd week	62nd week
64th week	64th week	64th week	64th week	64th week
66th week	66th week	66th week	66th week	66th week
68th week	68th week	68th week	68th week	68th week
70th week	70th week	70th week	70th week	70th week
72nd week	72nd week	72nd week	72nd week	72nd week
74th week	74th week	74th week	74th week	74th week
76th week	76th week	76th week	76th week	76th week
78th week	78th week	78th week	78th week	78th week
80th week	80th week	80th week	80th week	80th week
82nd week	82nd week	82nd week	82nd week	82nd week
84th week	84th week	84th week	84th week	84th week
86th week	86th week	86th week	86th week	86th week
88th week	88th week	88th week	88th week	88th week
90th week	90th week	90th week	90th week	90th week
92nd week	92nd week	92nd week	92nd week	92nd week
94th week	94th week	94th week	94th week	94th week
96th week	96th week	96th week	96th week	96th week
98th week	98th week	98th week	98th week	98th week
100th week	100th week	100th week	100th week	100th week

ENAMEL ORGAN

The enamel organ is composed of ectodermal epithelial cells and is at first only a thickening of the outer end of the tooth bud. It then becomes cup-shaped and the half-shaped growing out on the lateral side of the tooth bud. Next as a process in size and volume the dentine papilla is formed. The enamel organ is divided into three layers: the External Epithelium, composed of outer cells, the Middle Epithelium, composed of middle cells, and the Internal Epithelium, composed of large, long granular columnar cells with the nucleus of the outer end.

The function of the

External epithelium is to form the enamel.
 Middle epithelium is to form the dentin.
 Internal epithelium is to form the pulp chamber.

The enamel organ only becomes fully developed when it is going to produce enamel. It is contained in a thin layer of oral cells as in the case of the rest of the tooth. This organization is called the "Epithelial Sheet of Hertwig".

DENTINE PAPILLA

The dentine papilla is at first only a thickening of the mesoderm in front of the enamel bud. It grows into the enamel with dentin cells (odontoblasts) and later into the pulp chamber. The dentin papilla will later on form the pulp chamber and later on to form the dentin papilla. It is supplied with blood vessels and nerves.

DENTAL FOLLICLE

The dental follicle is first appears as a thickening of the mesoderm with outside the enamel organ and dentin papilla. It then is composed of very loosely packed cells. It becomes differentiated into an outer layer, the dental follicle, and an inner layer, the dental pulp. The dental pulp is formed from the dental pulp cells which migrate into the enamel organ. The dental pulp is formed from the dental pulp cells which migrate into the enamel organ. The dental pulp is formed from the dental pulp cells which migrate into the enamel organ.

When a very thick layer of connective tissue is formed the layer below is called the "Cement organ".

A small formation exists behind the rest of the temporary teeth for the replacement of a tooth. It is called the "Dental Lamina" and is formed from the dental pulp cells.

CALCIFICATION—Impregnation with lime salts.

Excretion theory (mollusks) ; **Conversion theory**.

CALCOSPHERITES and **CALCOGLOBULIN**.

(Woodhead's theory of Degeneration and Dialysis.)

ENAMEL.**Facts.**

Large granular Ameloblast cells, with nuclei at their outer end, exist.

In the corners of these cells, Fibrils appear (Osteo-genetic fibres).

The corners become tougher (calcoglobulin, "membrane").

Lime salts are deposited in the corners (middle soft part is Tomes' process).

All these changes spread inwards and upwards.

(In **Marsupials** the centre of the prisms remain uncalcified).

Theories.

Cells grow at nucleus end and become impregnated with lime salts at the other end (Conversion theory).

Cells grow at inner end, and the new part becomes impregnated.

Cells do not grow, but excrete matter from the inner end which becomes impregnated (Excretion theory).

DENTINE.**Facts.**

Odontoblasts with large nuclei and rounded ends, imbedded in a slightly fibrous matrix, exist. Toughening of the matrix occurs, then a deposit of calcospherites. The Odontoblasts move off, but leave strips behind them (Dentinal fibrils). The toughness follows and surrounds them (Sheath of Neumann).

Lime salts are deposited in between the fibrils (Dentine matrix).

Theories.

Odontoblasts form matrix sheath and fibrils.

Odontoblasts secrete a fibrous matrix, and themselves form the fibrils.

Odontoblasts form fibrils, and Intercellular substance forms matrix (Mummery).

VASO-DENTINE.**Fact.**

The fibrous matrix is better seen.

Theory.

Same as before, but the Odontoblasts move away completely, and the Capillaries do not.

OSTEO-DENTINE.**Fact.**

Calcification occurs on the surface and IN THE SUBSTANCE of the pulp also.

Theory.

Same as for Ossification in membranous bone.

CEMENTUM.**Facts.**

A fibro-cellular membrane exists and becomes impregnated with lime salts.

When a very thick mass of cementum is formed, the fibrous membrane becomes cartilaginous before calcification occurs (Cement organ).

Theory.

Cementoblasts form both Matrix and Lacunæ.

CALCIFICATION

Excretion from (tooth) ; Conversion from
CALCOPHOSPHATE and CALCOBOSULPHATE
(Woodward's theory of Deposition and Calcification)

ENAMEL

Fact:

Large granular Amorphous cells with nuclei at their outer end, and
in the center of these cells. (These granules are known as
The enamel granules or "enamel cells")
These cells are deposited in the enamel (under the part of Tooth's process)
All these granules spread towards and upwards
(In the direction of the center of the enamel granules)

Theory:

Cells grow in number and become impregnated with lime salts at the outer end (Conversion theory)
Cells grow in size and the new part becomes impregnated
Cells do not grow, but enamel matter from the inner end which becomes impregnated (Lambert theory)

DENTINE

Fact:

Granules with large nuclei and rounded ends, deposited in a slightly fibrous matrix. (Woodward's
of the matrix occurs from a deposit of calcium phosphate. The Granules move on but have steps
formed from (Woodward's theory). The granules diffuse and surround them (Sheath of Woodman)
Cells are deposited in between the cells (Woodman's theory)

Theory:

Granules form matrix slowly and steadily
Granules move in fibrous matrix and themselves form the matrix
Granules form matrix and later on diffuse and surround them (Woodman's theory)

VASO-DENTINE

Fact:

The fibrous matrix is dense near

Theory:

There is a layer of the (Woodman's) near every capillary and the Capillaries do not

OSTEO-DENTINE

Fact:

Calcification occurs on the surface and in the interior of the pulp also

Theory:

There is no transition in vascularization

CEMENTUM

Fact:

A fibro-cellular substance exists and becomes impregnated with lime salts
When a very thin layer of cementum is formed, the fibrous substance becomes calcified below
Calcification occurs (Cement theory)

Theory:

(Woodman's theory from both Matrix and Lamellae)

DEVELOPMENT OF THE JAWS.

LEARN THE DEVELOPMENT OF THE HEAD AND THE CENTRES OF OSSIFICATION OF THE JAWS.

CONDITION OF THE JAWS:—

Before Birth.

At Birth.

The lower jaw is in two halves.

The coronoid process rises at angle of 45° from the anterior margin of the crypt of M₁.

The condyle is level with the alveolus.

The symphysis is flat behind, no chin, the lower border of the jaw is convex.

The CRYPTS are open, incomplete, and packed.

The malar process is opposite the second temporary molar.

The ANTRUM is a mere depression. (Teeth up against orbit.)

TEETH:—

8 Months.

The halves of the lower jaw are uniting.

The coronoid process is farther back, the condyle is rising.

The symphysis bulges behind, chin, the lower border of the jaw is concave.

The CRYPTS in front have closed and re-opened; at the back are incomplete.

The antrum extends $\frac{2}{3}$ across the orbit.

Teeth. $\frac{1}{2}$ root, $\frac{1}{3}$ root, $\frac{2}{3}$ crown, all crown, all crown, cusps united.

Adult AGE.

The coronoid process rises at a right angle from behind the wisdom tooth.

The condyle stands high above the alveolus.

The sockets are all regularly arranged.

The malar process is opposite the first permanent molar.

The antrum forms a wide space between the teeth and orbit.

Old AGE.

The alveolus has all gone.

The angle has been much absorbed.

The chin is protruded. (Closure of bite.)

GROWTH takes place

At all sutures (till united).

Beneath the periosteum.

In the sub-articular cartilage.

The **Alveolar** portion grows, is absorbed and grows again exactly as it is required by the **Teeth**.

The **Basal** portion steadily grows according to the **Muscular** development, and so becomes a little wasted in old age.

The **Ascending Ramus** grows more rapidly than the basal portion, to provide room for the teeth. (Depth of bite and of antrum.)

THE LOWER JAW increases in **length** by growth:—

1. Beneath the periosteum behind the ascending ramus.
2. In the sub-articular cartilage of the **OBLIQUE** set ramus.
3. Beneath the periosteum in front of the jaw.

THE LOWER JAW increases in **width** by:—

1. Elongation of the jaw (continuance of arch).
2. Sub-periosteal growth on outer side of jaw.
3. Growth between the halves. (Mainly intra-uterine.)

DEVELOPMENT OF THE JAW

LEARN THE DEVELOPMENT OF THE HEAD AND THE ORIGIN OF THE JAW

Continuation of the Jaw—

Before Birth

At Birth

The first jaw is in two halves.
 The coronoid process rises at right angles to the vertical margin of the body of the condyle.
 The condyle is in line with the alveolar.
 The symphysis is not united, on each side the lower border of the jaw is united.
 The centers are open, intercondylar and located.
 The molar process is opposite the second temporary molar.
 The external is a very dependent. (Tooth up against tooth.)
 There—

8 Months

The bodies of the lower jaw are united.
 The coronoid process is further back the condyle is rising.
 The symphysis begins behind, then the first border of the jaw is complete.
 The centers are from jaw closed and separated; at the back are incomplete.
 The external extends 2 inches the tooth.
 Teeth 4 root 4 root 4 root all roots all roots all roots united.

Adult age

The coronoid process rises at a right angle from behind the wisdom tooth.
 The condyle stands high above the alveolar.
 The wisdom are all regularly extended.
 The molar process is opposite the first permanent molar.
 The external forms a wide space between the teeth and alveol.

Old age

The alveolar has all gone.
 The angle has been much flattened.
 The chin is protruded. (Chin out of line.)

GROWTH takes place

All the centers still united.
 Remains the permanent.
 In the intercondylar center.
 The alveolar portion grows in alveolar and grows again exactly as it is required by the teeth.
 The total action chiefly grows according to the Huxley's development, not as before. This action is the same.
 The Alveolar portion grows more rapidly than the total portion, so growth soon for the teeth. (Tooth) of the end of alveolar.

THE LOWER JAW increases in length 1/2 inch

1. Forward the posterior teeth the condylar center.
2. In the sub-condylar portion of the condyle and there.
3. Forward the condyle in front of the jaw.

THE LOWER JAW increases in width 1/2 inch

1. Expansion of the jaw (condyle of jaw).
2. Sub-condylar growth on each side of jaw.
3. Growth between the teeth. (Mainly intercondylar.)

ERUPTION OF THE TEETH.

FACTS.

Large multinucleated cells appear on the under side of the roof and front wall of the bony crypts.
 The roof of the crypt is absorbed away, and more than enough room made for the tooth to pass out.
 The soft tissues disappear and the tooth moves up.
 The alveolus closes in around the neck of the tooth and both grow up together.

THEORIES.

No fully satisfactory theory is at present known, but the following have been hatched.
 That the eruption of teeth is due to:—

1. The elongation of the roots, BUT teeth move farther than the length of their roots.
2. The enamel of the tooth acting as a foreign body, BUT the teeth of the sloth, which have no enamel, erupt.
3. The blood pressure, BUT why do they stop?
4. Enamel being an epithelial structure and therefore tending to return to the surface, BUT glands and nerves do not erupt.

TIMES OF ERUPTION OF THE TEMPORARY TEETH.

Lower centrals	about 6th month and take 10 days followed by a rest of 2 months.
Upper incisors	" 9th " " 1 month " " " 2 months.
L. laterals and 1st molars	" 12th " " 2½ months " " " 3 months.
Canines	" 18th " " 2 months " " " 5 months.
2nd molars	" 26th " " 3 months.

Struma and syphilis accelerate the eruption of teeth, rickets retards the eruption.

CONDITION OF THE JAWS AT THE AGE OF SIX YEARS.

The temporary teeth are fully calcified, spaced, partly absorbed, and vertical in direction.
 There is a wide space behind the last temporary molar.
 The permanent teeth are packed, partly calcified, obliquely placed, and placed behind or between the roots of the temporary teeth.

LEARN THE POSITION AND DIRECTION OF EACH TOOTH.

ROOM FOR THE PERMANENT TEETH IS MADE BY:—

1. The oblique direction of the erupting teeth.
2. The thickening of the jaw by sub-periosteal growth externally.
3. The smaller antero-posterior diameter of the bicuspids than of the temporary molars.
4. The elongation of the jaw backwards.

ABSORPTION OF THE TEMPORARY TEETH is caused by an "ABSORBENT ORGAN," not by pressure.

LEARN TO RECOGNISE and explain:—

"GIANT CELLS."
 "HOWSHIP'S LACUNÆ."

TIMES OF ERUPTION OF THE PERMANENT TEETH.

	I ₁	I ₂	C.	B ₁	B ₂	M ₁	M ₂	M ₃
Upper	7¼	8¾	11¾	10¼	11¼	7½	12¾	24 years.
Lower	7¼	8¼	10¾	10¾	11¼	7	12½	24 years.

Girls cut their canines and 2nd molars earlier than boys.

Rich children cut their teeth earlier than poor children.

ERUPTION OF THE TEETH

FACTS

Large undifferentiated cells appear on the outer side of the root and front wall of the pulp organ. The end of the organ is elevated away, and more than enough room made for the tooth to pass out. The end tissues disintegrate and the tooth moves up. The enamel layer is around the body of the tooth and both grow up together.

THEORIES

- No fully satisfactory theory is at present known, but the following facts have been established:
1. The elongation of the roots, BUT both move farther than the length of their roots.
 2. The enamel of the tooth acting as a foreign body, BUT the teeth of the right which have no enamel erupt.
 3. The blood pressure, BUT why do they erupt?
 4. Enamel being an epithelial structure and therefore tending to return to the surface, BUT glands and nerves do not erupt.

TIMES OF ERUPTION OF THE TEMPORARY TEETH

Teeth	Age	Time of eruption
Lower central	about 6 1/2 months	10 days followed by a rest of 2 months
Upper incisors	8-9	1 month
Lower lateral and 2nd molars	12-13	2 months
Canines	18-20	3 months
2nd molars	24-26	7 months

Stomach and epiphys contribute the nutrition of teeth, which reaches the eruption.

CONDITION OF THE JAWS AT THE AGE OF SIX YEARS

The temporary teeth are fully erupted, period partly finished, and normal in distribution. There is a wide space behind the last temporary molar. The permanent teeth are packed, partly erupted, irregularly placed, and placed behind or between the roots of the temporary teeth.

LEARN THE POSITION AND DIRECTION OF EACH TOOTH

ROOM FOR THE PERMANENT TEETH IS MADE BY:

1. The oblique direction of the erupting teeth.
2. The recession of the jaw by undifferentiated growth especially.
3. The early absorption of the temporary teeth.
4. The recession of the jaw backwards.

ABSORPTION OF THE TEMPORARY TEETH IS CAUSED BY AN ABSORBENT ORGAN, THE P

PERIODONTIUM

LEARN TO RECOGNISE AND REPRODUCE

DIAGRAM OF
HOWARTH'S JAWLINE

TIMES OF ERUPTION OF THE PERMANENT TEETH

Teeth	Age	Time of eruption
Lower	6-7	1 year
Upper	7-8	1 1/2 years

Life on their enamel and 2nd molar erupts later than the 1st molar and that teeth erupt later than the 2nd molar.

THE ATTACHMENT OF TEETH

Is by:—Membrane, hinge, anchylosis, or socket.

BY FIBROUS MEMBRANE.

The teeth are embedded in a fibrous membrane which revolves over the jaw, *e.g.*, **Sharks** and **Rays**.

Or the teeth are bound down to a pedestal of bone by an annular ligament, *e.g.*, **Sargus**.

BY A HINGE.

(a.) **ELASTIC.** The hinge itself is elastic and pushes up the tooth, *e.g.*:—

Lophius (angler).

Hake (merlucius).

Odontostomus.

Bathysaurus.

(b.) **NON-ELASTIC.** The tooth is erected by elastic fibres in the pulp cavity, *e.g.*:—

Pike (esox).

BY ANCHYLOSIS.

The teeth are fixed to the jaw bone by "**Bone of Attachment**," which is probably formed from the periosteum of the jaw, *e.g.*:—

Pike and **Python**.

Eel, **Chameleon**. (**Acrodont**, *i.e.*, on a pedestal of bone.)

Frog, **Iguanodon**, **Varanus**. (**Pleurodont**, *i.e.*, to an external parapet of bone.)

Haddock.

Mackerel.

BY SOCKET (*gomphosis*).

The teeth are bound to the walls of a socket by a fibrous membrane, *e.g.*:—

Man, and most **Mammals**.

Also the **File Fish**,

Lepidosteus,

Baracuda Pike,

The Dermal **Spines** of the **Pristis**,

Ichthyosaurus,

Crocodile. (The same socket serves throughout life; only the teeth change.)

THE ATTACHMENT OF TEETH

is by attachment from ankylosis or socket

BY FIBROUS MEMBRANE

The tooth is embedded in a fibrous membrane which invests over the jaw, viz., Sharpey and Kaye. On the neck are found down to a pedestal of bone by an annular ligament, viz., Sharpey.

BY A HINGE

(1) ELASTIC The bone itself is elastic and pushes up the tooth, viz.,

- Ligament (anterior)
- Alveolar process
- Oblique foramen
- Alveolar process

(2) NON-ELASTIC The tooth is fixed by elastic fibres in the pulp cavity, viz.,

File (tooth)

BY ANCHYLOSIS

The tooth is fixed to the jaw bone by "Bone of Attachment", which is probably formed from the junction of the jaw, viz.,

- File and Yiphan
- Ear Chamber (Acrodont, viz., on a pedestal of bone)
- Foot (Acrodont, Yiphan, Pseudodont, viz., in an external part of bone)
- Radical
- Radical

BY SOCKET

The tooth is fixed to the wall of a socket by a fibrous membrane, viz.,

- Ear and neck (Kammeln)
- Ear and the jaw
- Ligament
- Alveolar pit
- The Dental Epithelium of the Pith
- Ligament
- Alveolar (The same socket exists throughout life, only the tooth changes)

THE TEETH OF FISHES.

Morphology (MORPHOLOGY is the science of structure and form).

HOMOLOGY.

Diagrams to show that **Dermal Spines** and **Teeth** have the same **ORIGIN** and **STRUCTURE**.

STRUCTURE.

HORNY TEETH consist of **Hardened Epithelium** only, *e.g.*:—

Lamprey, Myxine.

CALCIFIED TEETH consist of:—

Dentine	{	Fine tubed dentine	Carcharias, and many others.
		Plici-dentine	Lepidosteus and diagram.
		Vaso-dentine	Hake, Flounder.
		Osteo-dentine	Shark, Pike.
Enamel	{	Tips only	Eel, Hake, Chætodonts.
		Thin layer (?)	Sharks, Pike.
(Sometimes the enamel is Tubular , <i>e.g.</i> , Porbeagle Shark and Sargus.)			
Cementum is rare.			
"Bone of Attachment"		Eel, Hake, &c.	

MODE OF ATTACHMENT (*see page 13*).

FORMS. Most are **Homodont** and of simple forms.

Cones	Sharks, <i>e.g.</i> , Carcharias, &c., &c.
Slender rods	Chætodonts { dents en velours. " " brosse. " " cardes.
Flat plates	Rays, <i>e.g.</i> , Rhyncobates.
A few are Heterodont	{ Anarehus Lupus, Cestracion Phillipi.
One shows Sexual differences	Raia Clavata.

SUCCESSION is continuous.

Several rows at a time	{ Raia Maculata, American Shark.
One row at a time	{ Carcharias Lamna (alternate teeth), Greenland Shark.
Irregular succession	The teleostei, <i>e.g.</i> , Pike (<i>next case</i>).
Vertical succession	File Fish,
	Lamprey,
	Wrasse,
Fused vertical succession	Pseudo-Scarus, Baracuda Pike (sphyraena pic).
	Poreupine Fish (gymnodont).
	Parrot Fish (scarus) (" ").
	Lepidosiren (mud fish).
	Ceradotus Forsteri.

(Scarus, pharyngeal teeth \rightarrow ; *next case*).

DISTRIBUTION.

Margins of the jaws only, in the **Sharks** and **Rays**.

All over the mouth and pharynx in the **Teleostei** (*see next case*).

e.g.:—Amia Calva, Cod, Pike, Sun Fish, Wrasse, Scarus.

Some fish are **edentulous**.

e.g.:—Pipe Fish, Hippocampus, Sturgeon.

THE TEETH OF FISHES

Morphology morphology is the science of structure and form.

HOMOLGY

Dentures of the same type that Dental Spines and Teeth have the same Origin and Structure.

STRUCTURE

Many Teeth consist of Hardened Epithelium only, e.g.

Shark's Teeth

Calcified Teeth consist of

Two solid dentine

Two dentine

Two dentine

Two dentine

Two dentine

Two dentine

Two dentine

Two dentine

Two dentine

Cartilage and many others

Cartilage and dentine

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

MODE OF ATTACHMENT (See page 12)

FORM

Most are Homodont and 1 single form

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

SUCCESSION

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

DISTRIBUTION

Most of the teeth are in the jaws and gills

All over the body and gills in the shark's teeth

Shark's Teeth

Shark's Teeth

Shark's Teeth

THE TEETH OF FISHES.

Fishes are divided into—**Leptocardii, Cyclostomata, Palaeiethyes, and Teleostei.**

LEPTOCARDII. **Amphioxus**, no jaw and no teeth. (*Wall case.*)

CYCLOSTOMATA. **Lamprey**, horny teeth; vertical succession.
Myxine, horny teeth; rudimentary calcified teeth.

PALAEIETHYES. Ganoids, Sharks and Rays (*Elasmobranchii and Ganoidii.*)

GANOIDS. **Lepidosiren** . . . } | have grooved teeth made up of superimposed plates of enamel only;
Ceradotus Forsteri } | and a few teeth on the vomer.
Sturgeon . . . Edentulous.
 (The Larval **Sturgeon** has teeth.)
Polyodon . . . has many minute teeth.

SHARKS. Polyphyodont; homodont; conical teeth; osteo-dentine and a thin covering of enamel (?).
Cestracion . . . is heterodont.

RAYS. More flattened teeth, plicid-dentine.

Myliobates.

Aetobates.

Pristis has socketed Dermal spines of continuous growth. Plicid-dentine. Teeth like ordinary ray's.

Raia Clavata has sexual teeth.

TELEOSTEI.

Pike. Osteo-dentine, hinged and anchylosed teeth. Teeth on the vomer, palate, and pharynx.
Lophius. Vaso-dentine. Elastic hinged and anchylosed teeth.
Wolf Fish. Heterodont. (*Chrysophys laticeps.*)
Gymnodonts. Fused vertical succession, pharyngeal teeth.
Pseudo-Searus. Vertical succession.
Sargus. Tubular enamel, vertical succession, sockets, remains of VASCULAR canals (in the dentine).
Pipe Fish. Edentulous.
Hippocampus. Edentulous.
Carp. Edentulous mouth, but pharyngeal teeth.
File Fish. Vertical succession and socketed teeth.
Amia Calva. Shows well the bones on which teeth grow.
Wrasse. Peculiar succession of pharyngeal teeth, vertical succession of front teeth.

BATRACHIANS.*(Case on the wall.)*

Two rows in the upper and one in the lower jaw; homodont, haplodont; endless vertical succession; ankylosis; fine tube dentine, enamel tips.

Toad	Edentulous.
Frog	One row in upper and none in lower jaw; (a few teeth on the vomer).
Tadpole	Horny plates and hooks on lip.
Newts	Double enamel tips.
Salamanders }	
Labyrinthodon	Plici-dentine.

REPTILES.**CHELONIAN REPTILES.***(Turtles and tortoises.)***Horny Plates.**

CARNIVOROUS.	Sharp-edged plates, Hawk's-bill Turtle.
HERBIVOROUS.	Blunt and serrated plates, Common Turtle.

SAURIAN REPTILES.*(Lizards, &c.)*

Teeth confined to edge of jaws; continuous vertical succession; homodont, haplodont; ankylosis; hard dentine and enamel.

Varanus	has plici-dentine.
Iguanodon	has vaso-dentine.
Heloderma	has poisonous, grooved teeth.
Sphenodon	Large upper incisors bite on BARE bone of lower jaw. It is monophyodont.
Chameleon	is monophyodont.

OPHIDIAN REPTILES.*(Snakes.)*

Two rows of teeth in the upper jaw (the **OUTER** row on the **SUPERIOR MAXILLARY** bone, and the **INNER** row on the **PALATE** and **PTERYGOID** bones), and one row in the lower jaw (**MANDIBLE**); continuous succession, homodont, recurved cones, ankylosed; hard dentine and enamel.

NOTE THE METHOD OF SWALLOWING AND ADAPTATION THERETO OF DEVELOPING TEETH.

PYTHONS are non-poisonous; their teeth have no grooves; they have two complete upper rows of teeth.

COLUBRINE.

1. **A-GLYPHA** Teeth not grooved; non-poisonous.

Dasypeltis (Rachiodon), egg snake, has few teeth.
Common English Snake.

2. **OPISTHO-GLYPHA.** Post. Max. teeth are grooved; slightly poisonous.
Tree and Whip Snakes.

3. **PROTERO-GLYPHA.** Ant. Max. teeth are grooved or tubular. Post. Max. and Pterygoid teeth are small and few; Max. bone is fixed; poisonous.

Hydrophis. - 5 or more teeth on maxillary line

Cobra has slight movement of the Max. bone.

Crait.

Australian Death Adder and Hamadryad.

VIPERINE have a **Movable Max. bone**; a large poison fang with a complete tube

Puff Adder.

Rattle Snake.

Viper.

STUDY THE MECHANISM, STRUCTURE, SUCCESSION OF THE POISON FANG *(see previous case).*

BATRACHIANS

Two rows in the upper and one in the lower jaw; homodont; haplobont; endless vertical succession; anchiolysis; fine tooth dentine enamel tips

Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth

REPTILES

CHelonian Reptiles

Carapace and plastron
 Homodont; haplobont; endless vertical succession; anchiolysis; fine tooth dentine enamel tips

Saurian Reptiles

Teeth confined to edge of jaws; continuous vertical succession; homodont; haplobont; anchiolysis; hard dentine and enamel

Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth
Teeth	Teeth

Ophidian Reptiles

Two rows of teeth in the upper jaw (the outer row on the superior maxillary bone and the inner row on the palata and preopercular bones) and one row in the lower jaw; homodont; continuous succession; homodont; recurved cones; anchiolysis; hard dentine and enamel

NOTE THE METHOD OF SWALLOWING AND EXCRETION THEREOF OF DEVELOPING TEETH AND NON-POISONOUS; THEN TEETH HAVE NO GROOVES; THEY HAVE TWO COMPLETE UPPER ROWS OF TEETH

Coleurine

Teeth not grooved; non-poisonous

Teeth not grooved; non-poisonous

Teeth not grooved; non-poisonous

Teeth not grooved; non-poisonous

Viperine

Teeth not grooved; non-poisonous

CROCODILIA.

A single row; continuous vertical succession; homodont; haplodont; socketed; hard dentine, enamel and cementum.

Crocodile $\frac{3}{1} \frac{9}{4} \frac{9}{11}$ are large, a tendency towards a carnivorous formula.
Garial Slender teeth (Piscivorous).

Extinct Reptiles.

Some are more primitive, some much more specialised than modern reptiles.

ICHTHYOSAURUS has incomplete sockets. (Several varieties.)

DINOSAURUS.

Iguanodon Enamel—hard dentine—vaso-dentine. Keep sharp.

ANOMODONTIA Heterodont.

THERO-CHELONIA.

Dielynodon has persistent growing upper canines; horny plates (?).

THERO-SUCHIA.

Therodonts Not continuous succession.

Cynognathus Carnivorous, 4. 1 5. 4.

Placodus Gigas Incisors and flattened molars.

PTEROSAURIA (*Flying Reptiles.*) (*Geological Gallery.*)

Pterodaelytes Slender sharp teeth all along the jaw.

Rhamphorhynchus No teeth in front, horny plates (?).

Pteranodon No teeth at all, horny plates (?).

BIRDS.

Edentulous, horny plates, often serrated.

Merganser Serrated beak.

Odontopteryx Toliopieus Bony prominences to correspond.

Archæopteryx Teeth.

ODONTOTORNÆ.

Ichthyornis 21 homodont, haplodont teeth (horny plates in front?); continuous vertical succession, socketed, hard dentine and enamel.

ODONTOLCÆ.

Hesperornis $\frac{1}{3} \frac{1}{3}$ homodont, haplodont teeth, continuous vertical succession, incomplete sockets; hard and osteo dentine and enamel.

Notice the "egg tooth" shown on a chick at the far end of the case; egg teeth also occur in snakes.

CROCODILIA

A single row; continuous vertical succession; homodont; reptodont; socketed; hard dentine, enamel and cementum.

Crocodylids have large, a tendency towards a homodont dentition. Mandible teeth (heterodont)

Extinct Reptiles

Some are more primitive, some much more specialised than modern reptiles.

has incomplete sockets (dorsal varieties) ICHTHYOSAURUS

Isospondylous Iguanodon DINOBAURUS

Heterodont ANOMODONTIA

has prominent dorsal (upper jaw) teeth (horny plates?) THERO CHELONIA

Not continuous succession THERO SUEVIA

Continuous & I & I Tetractylus THERO DIPSOSAURUS

Isospondylous THERO DIPSOSAURUS

Isospondylous PTEROSAURIA

Isospondylous Pterosaurs PTEROSAURIA
No teeth at all (horny plates?)
No teeth in lower jaw (horny plates?)
Teeth sharp with all along the jaw

BIRDS

Edentulous, horny plates, often scaly

Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly

Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly

Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly

Edentulous, horny plates, often scaly
Edentulous, horny plates, often scaly

HOMOLOGIES OF THE TEETH.

THEORIES.

1. That several simple teeth become fused to form a complex tooth.
(*Rose, Kükenthal, and Virchow.*)
2. That new cusps are developed on an originally simple tooth.
(*Cope and Osborn's Tritubercular theory.*)

STAGES OF TRITUBERCULISM.

(You must draw diagrams.)

1.	Haplodont (No early example)	Protocone, -id.
2.	Protodont Dromatherium	" "
3.	Triconodont Triconodon	{ Paracone, -id. Metacone, -id.
4.	Tritubercular Spalacotherium	

The Protocone is Inside and the Protoconid is Outside. Para- is Anterior.

From the Tritubercular tooth all existing forms are derived by:—

1. Addition of cusps. (*Hypocone -id.; Entacone, -id.; Proto- and Meta-conule.*)
2. Addition of some cusps and suppression of others.
3. Elevations of the **cingulum**.
4. Foldings of the dental tissues.
5. Suppression of some of the **dental tissues**.
6. Addition of new **tissues**. Secondary dentine and cementum on the crown.
7. Lengthening of the cusps.

EXAMPLES.

1. **Addition of cusps.** The lower carnassial tooth of the **Dog**, in which the paraconid, protoconid, and metaconid are united to form the blade, and a small heel (hypoconid) is added behind. In the **Bear** an entaconid is also added.
2. **Addition and suppression of cusps.** In the lower carnassial tooth of the **Tiger** the metaconid is gone (hence there are only two cusps to the blade), and a heel (hypoconid) is added.
3. **Elevation of the cingulum.** In the **Insectivora** the cingulum is raised both on the lingual and buccal aspects to form extra cusps.
In the **Suina** the cingulum is raised distally to form cusps (*e.g.*, **Phæcochærus**, and to a less extent the **Pig**).
In the **Mastodon** and **Elephants** we have another example of the same thing, plus a lengthening of the cusps and a shortening of the roots.
4. **Folding of the tissues.** In the incisors of the **Horse** and the molars of some **Rodents**.
5. **Suppression of tissues.** The partial covering of enamel on the incisors of **Rodents**, canines of **Pigs**; and its entire absence from the teeth of **Edentata**.
6. **Addition of tissues.** In the persistent growing teeth of the **Sloths** and **Rodents** the pulp cavities are filled up with secondary dentine of a different type.
7. **Lengthening of cusps.** In the hypsodont teeth of **Ruminants**, and still more in the persistent growing teeth of **Rodents**.

The molars of the **Horse** show an addition and lengthening of cusps, an elevation of the cingulum, and a thickening of cementum.

Many people do not accept the "Tritubercular theory" **in toto**, because:—

1. The earliest known mammals had "Multitubercular" teeth.
2. Authorities differ as to the identification of cusps in many cases.
3. It places the growth of the cingulum in a very secondary place.
4. The order of calcification does not always agree with the accepted homologies of the cusps.

HOMOLOGIES OF THE TEETH

THEORIES

1. The original simple tooth became fused to form a complex tooth (Huxley, Koberstein, and Jordan)
2. The two simple teeth developed in an originally simple tooth (Lillie and Turner's Trilobular theory)

STAGES OF TRITUBERCULISM

(The early stages)	(The early stages)	(The early stages)
Tribulocera	Tribulocera	Tribulocera
Tribulocera	Tribulocera	Tribulocera
Tribulocera	Tribulocera	Tribulocera

The Tribulocera is fused and the Tribulocera is fused. The Tribulocera is fused.

From the Tribulocera tooth all existing forms are derived in

1. Addition of cusps (Wagner, de Meek, and Woodward)
2. Addition of some cusps and apposition of enamel
3. Elevation of the cingulum
4. Folding of the dental tissue
5. Suppression of some of the dental tissue
6. Addition of new tissue, boundary between and connection on the crown
7. Lengthening of the cusps

EXAMPLES

1. Addition of cusps. The lower carnassial tooth of the dog in which the furcated posterior and anterior are fused to form the block and a small tooth (hypocaul) is added behind. In the case of man the small tooth is also added.
 2. Addition and suppression of cusps. In the lower carnassial tooth of the tiger the posterior is gone (some have one or two cusps to the block) and a small (hypocaul) is added.
 3. Elevation of the cingulum. In the mandible the cingulum is raised back on the lateral and medial sides to form a low ridge.
 4. In the horse the cingulum is raised higher to form cusps (e.g. Pinnaculum) and to a low extent to the eye.
 5. In the Tribulocera and Tribulocera we have similar examples of the same thing plus a lengthening of the cusps and a shortening of the neck.
 6. Folding of the tissue. In the molar of the horse and the molar of some rodents.
 7. Suppression of tissue. The partial retention of enamel on the lingual of rodents, molar of the horse and in other species from the tooth of rodents.
 8. Addition of tissue. In the posterior growing teeth of the horse and rodents the pulp cavities are filled with secondary dentine of a different type.
 9. Lengthening of cusps. In the upper teeth of rodents and still more in the posterior growing teeth of rodents.
- The molar of the horse shows an addition and lengthening of cusps, an elevation of the cingulum, and a shortening of the neck.

They do not accept the Trilobular theory, in fact, however.

1. The molar tooth remains but "Mandibular" teeth.
2. Anterior teeth as in the dentary series of teeth in many cases.
3. It shows the growth of the cingulum in a very secondary phase.
4. The order of calcification does not always agree with the accepted homologies of the cusps.

TOOTH SUCCESSION.

FISHES	Continuous succession (Polyphyodont)	One tooth band	Sharks and Rays.
		No tooth band	Pike, &c.
REPTILES	Continuous succession (Polyphyodont)	One tooth band	Newt and Snake.
BIRDS (extinct).	Continuous succession (Polyphyodont)	One tooth band	Hesperornis.
MAMMALIA	Two sets (Diphyodont)	One tooth band	Man.
	One set (Monophyodont)	One tooth band	Rat.

Possibly there are also a "PRE-MILK" and a "POST-PERMANENT" set in some mammalia.

THEORIES to account for two (or more) sets:—

1. Descent from **Polyphyodont** ancestors.
2. **Folding** of tooth band from shortening of face.

The **Milk Dentition** resembles the permanent **Dentition**.

Hence milk **MOLARS** resemble permanent **MOLARS**, not premolars.

But, **Sexual** teeth are ill marked, also

The **Orycteropus** has **HETERODONT** and **ROOTED** milk teeth, and homodont, persistent growing permanent teeth;

The **Balaenoptera Rostrata** has **HERERODONT** rudimentary milk teeth, and no permanent teeth;

The **Chiroptera** have small hook-shaped milk teeth, and very heterodont permanent teeth;

The **Aye-Aye** has **LEMURINE** milk and a **RODENT** permanent dentition;

The **Wombat** has milk **CANINES** and a **RODENT** permanent dentition.

Permanent **Molars** are either:—

1. Milk teeth (*Rose, Kukenthal, and Leche*).
2. Permanent teeth (*Woodward, Magitot, and Tomes*).
3. A fusion from both sets (*Kukenthal and Schwalb*).
4. Terminal members of separate sets.

DEGREES OF DEVELOPMENT OF MILK TEETH.

1. Not formed at all. **Sloths.**
 2. Partly formed, but uncalcified **Shrews.**
 3. Calcified, but unerupted **Seals.**
 4. Erupted, but soon shed **Bears.**
 5. A few only formed and functional **Dugong, Hedgehog.**
 6. All erupted and last some time **Dogs.**
 7. Last all life **Whales.**
- (Some "permanent" teeth are shed early *Dugong, Kangaroo, Wart-hog.*)

In many Ungulata, Carnivora, and Insectivora,

The first tooth behind the canine is small, cut late, lost early, and has no successor. Is it a first milk molar or a pre-molar?

TOOTH SUCCESSION.

One tooth band	One tooth band	One set (Monophodont)	MAMMALIA
One tooth band	One tooth band	Two sets (Diphyodont)	BIRDS (Artificial)
One tooth band	One tooth band	Continuous succession (Polyphyodont)	REPTILES
One tooth band	One tooth band	Continuous succession (Polyphyodont)	FISHES

Probably there are also a "PRE-MILK" and a "POST-PERMANENT" set in some mammals.

THEORIES IN REGARD TO THE (OR THEIR) ORIGIN.

1. Derived from Polyphyodont ancestor.
2. Folding of tooth band from shortening of jaw.

The Milk Dentition resembles the permanent Dentition.

There are three possible permanent dentitions, but the first is the most common. The second is the most common in the higher mammals, and the third is the most common in the lower mammals. The first is the most common in the lower mammals, and the second is the most common in the higher mammals. The third is the most common in the lower mammals, and the second is the most common in the higher mammals.

Evolutionary Motives are given.

1. Milk teeth (from embryonic and foetal).
2. Permanent teeth (from embryonic and foetal).
3. A lower set of teeth (from embryonic and foetal).
4. Permanent dentition of separate sets.

DEGREE OF DEVELOPMENT OF MILK TEETH.

1. Not formed at all.	Starfish
2. Fully formed but deciduous.	Crayfish
3. Deciduous but permanent.	Snake
4. Permanent but deciduous.	Snake
5. A few very deciduous and permanent.	Porpoise, Hedgehog
6. All deciduous and permanent.	Dog
7. Last all permanent.	Whale
8. Some permanent, some are deciduous.	Porpoise, Hedgehog, Whale

In many Vertebrates (Amphibians and Reptiles) the first tooth which the embryo is capable of using is deciduous, and has no successor. It is a true milk tooth or a pre-milk tooth.

SOME DETAILS ABOUT THE MILK TEETH OF MAMMALIA.

EDENTATA.	(Homodont and monophyodont.)
Bat in	
9 Banded Armadillo	Milk teeth till nearly full size.
Orycteropus	7 Rudimentary, calcified, heterodont, unerupted milk teeth; plici-dentine, non-persistent growth.
CETACEA.	(Monophyodont.)
Milk teeth persist all life. Permanent rudiments unerupted.	
SIRENIA.	
Dugong	Milk tusk only. (2nd Incisor?)
Manatee	$\frac{2}{3}$ $\frac{0}{1}$ $\frac{0}{3}$ Milk teeth. Perpetual succession of molars <i>à la</i> Elephant.
UNGULATA.	(Typical diphyodonts.)
In many dm_1 (pm_1 ?) has no successor.	
Timms found a "Pre-milk" tooth in the pig (?).	
Phacochærus sheds m_1 , pm_2 , m_2 , pm_4 of its permanent set.	
RODENTS.	(Few milk teeth.)
Hares	di_1 di_2 dm_1 dm_2 dm_3 } di_1 lost in utero.
Rabbits	di_1 dm_1 dm_2 } di_1 lost in utero.
Squirrel	di_1 di_2 dm_1 dm_2 dm_3 } di_2 and dm_3 lost in 18 days
Mouse	di_1 dm_1 dm_2 } (non-persistent growth).
Beaver	di_1 di_2 di_3 dm last till half grown.
Erethizon	di_1 ? dm last till half grown.
Guinea Pig	dm last till half grown.
Dasyprocta	dm last till half grown.
Ctenodactylus	dm last till half grown.
Hystrix	dm last till half grown.
Atherina	dm last till half grown.
Rat	Monophyodont.
CARNIVORA.	(Typical diphyodonts.)
In many dm_1 (pm_1 ?) has no successor.	
Felidae	3 1 3 Milk teeth.
All others	3 1 2 Milk teeth.
Bear	3 1 3 Milk teeth.
Seals	Loses milk teeth early.
Otaria	Have degenerate milk teeth.
Phocan Greelandica	3 1 3 Milk teeth. Last a few weeks.
Cystophora proboscidea	1 1 3 Milk teeth. Last a week.
Walrus	3 1 3 Milk teeth. Lost in utero.
Walrus	4 Milk teeth and 2 ? Lost at birth.
INSECTIVORA.	(Diphyodont.)
Galeopithecus	2 0 3 Milk teeth. Cut late. Work with true molars, di_1 lost early. Resemble pre-molars.
Hedgehog (erinaceus)	123 1 1234 Milk teeth. Those in italics functionless.
Gymnura	123 1 1234 Milk teeth. " " "
Shrew (sorex)	123 1 1234 Milk teeth. " " "
Mole (talpa)	23 1 34 All uncalcified.
Centetes	123 1 1234 Milk teeth. Lost early.
Hemicentetes	123 1 1234 Milk teeth. Lost early.
Macroscelides	dm_1 has no functional successor, and is retained late; dm_4 is two rooted and molariform.
Tupaia	dm_1 molariform.
Centetes	
Hemicentetes	
Macroscelides	Have good functional milk teeth.
Tupaia	
CHIROPTERA.	
Milk teeth ill-developed. Functionless. Often unerupted. Some persist with the permanent teeth, and are of very simple form, e.g., Vampire.	
PRIMATES.	(Diphyodont.)
Aye-aye	2 1 2 Milk teeth. Lost early.
Aye-aye	2 0 2 Milk teeth. Lost early.
MARSUPIALS.	
According to Wilson and Hill the Functional set are the Permanent set, and the Milk teeth are in various states of reduction.	
Wombat	1 1 1 Milk teeth. Lost early.
Wombat	0 1 1 Milk teeth. Lost early.
OTHER VIEWS.	
Kukenthal and Rose	Functional MILK teeth and rudimentary PERMANENT.
Woodward (didelphys)	Rud. PRE-MILK; Funct. MILK; Rud. PERMANENT.
Timms (didelphys)	Rud. MILK; Funct. PERMANENT; Rud. POST-PERM.
Leeche (myrmecobius)	Rud. PRE-MILK; Funct. MILK.

SOME DETAILS ABOUT THE MILK TEETH OF MAMMALIA

Order	Family	Genus	Species	Sex	Age	Location	Notes	
PRIMATES	Cercopithecidae	Macaca	M. mulatta	♂	Adult	Singapore	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Felidae	Panthera	P. tigris	♂	Adult	India	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Canidae	Canis	C. lupus	♂	Adult	Europe	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Ursidae	Ursus	U. arctos	♂	Adult	Russia	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Mustelidae	Martes	M. martes	♂	Adult	Europe	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Viverridae	Viverra	V. zibetha	♂	Adult	India	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Procyonidae	Procyon	P. lotor	♂	Adult	North America	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀
CARNIVORA	Mammalia	Mammalia	Mammalia	♂	Adult	Various	Milk teeth	
								♀
								♂
								♀
								♂
								♀
								♂
								♀
								♂
								♀

MAMMALIA.

PROTOTHERIA (*Monotremata*.)

- Echidna is edentulous.
 Ornithorhynchus has horny plates and rudimentary teeth above them.

EUTHERIA.

EDENTATA.

Monophyodont, homodont, no incisors, persistent growth. No enamel, hard dentine, and secondary dentine.

SLOTHS.

- Two-toed Sloth has one tooth larger than the rest.
 Three-toed Sloth is typical.
 Megatherium has vaso-dentine and cementum. Grooved molars.

ANT-EATERS.

- Manis, *Mutica*, Tamandua are edentulous.

ARMADILLOS.

- Six-banded Armadillo has rudimentary incisors.
 Nine-banded Armadillo is diphyodont.

ORYCTEROPUS (Cape ant-eater). (*Aard-Vark*.)

- Is diphyodont, heterodont, and has plici-dentine.
 Clyptodon had grooved molars.

CETACEA.

ODONTOCETI.

Monophyodont, homodont, haplodont, socketed teeth; hard dentine (interglobular spaces), enamel tips, cementum.

- Dolphin, Porpoise, Grampus are typical.
 Sperm Whale has rudimentary upper teeth and a few large lower teeth.
 Hyperodens *Bidens* has rudimentary upper teeth and two lower teeth.
 Ziphoids have two odd-structured lower teeth.
 Narwals have rudimentary and sexual incisors and an edentulous mouth.

The functional teeth of whales are said to be the **milk** teeth (CONTRAST WITH THE SEALS).

MYSTACOCETI.

Edentulous, rudimentary teeth. Whalebone.

- Balænoptera Rostrata* has heterodont rudimentary MILK teeth.
 Whalebone is homologous with the **enamel** of teeth, and not with the whole tooth.

SIRENIA.

Dugong has horny plates over rudimentary teeth. Five semi-persistent molars; and a tusk which is persistent growing in the male, rudimentary in the female. It is preceded by a milk tooth. An old animal loses some of its molars.

Manatee has horny plates and rudimentary teeth; many molars which erupt behind and move forwards in the jaw; straight prisms in the enamel, and the remains of vascular canals in the dentine.

Rhytina is extinct, was edentulous, and had horny plates.

MAMMALIA

PROTHERIA

... teeth ...

EUTHERIA

EDENTATA

Monophyodont, homodont, no incisors, persistent growth. No enamel, hard dentine, and secondary dentine.

BLIOTH

Two-tooth class ...

ANT-EATERS

... animals

ARMADILLO

... animals

ORYCTEROPUS

... animals

CETACEA

ODONTOCETI

Monophyodont, homodont, hapodont, socketed teeth; hard dentine (interglobular spaces). ... The functional teeth of whales are said to be the milk teeth (erupted with the milk).

MYSTACOCETI

Edentulous, rudimentary teeth. Whales ...

SIRENIA

Dugong has heavy plates over rudimentary teeth. ... The jaw, weight borne on the pectorals, and the muscles of respiration are in the denture.

UNGULATA.

UNGULATA VERA

Diphyodont; heterodont $\begin{smallmatrix} 1 & 1 & 3 \\ 3 & 1 & 4 \end{smallmatrix}$; enamel, hard dentine, cementum.

Brachyodont and hypsodont; bunodont, selenodont and lophodont.

- VEGETABLE DIET:—
1. LONG NARROW ARCH.
 2. REDUCTION OF FRONT TEETH.
 3. SUPPRESSION OF CANINES.
 4. DEVELOPMENT OF CHEEK TEETH.
 5. GLOBULAR CONDYLE.

ARTIODACTYLES *(even toed).*

Premolars differ markedly from true molars (simpler).

BUNODONTS *(non-ruminants).*

SUINA have large sexual persistent growing canines.

Pig and Collared Pecary are typical.

Phacochoerus has non-sexual canines *(large in both sexes)*. A large M_3 .

Sus Babirusa has the longest canines (no enamel).

HIPPOPOTAMI Both incisors and canines are of persistent growth.

SELENODONTS *(ruminants)* $\begin{smallmatrix} 0 & 1 & 4 & 3 \\ 3 & 1 & 3 & 2 \end{smallmatrix}$ No upper incisors.

TYLOPODIA.

Camel has good canines; $1_1 1_2$ are lost early.

TRAGULIDÆ.

Chevrotians have large sexual persistent growing canines.

PECORA.

Bovidæ have no canines; hypsodont teeth and thick cementum over the enamel.

Sheep. Oxen. Antelopes.

Giraffidæ.

Giraffe has no canines.

Cervidæ have small canines: brachyodont teeth and no cementum on the crowns.

Musk Deer has large sexual canines.

Muntjak has large canines and small horns.

Hydropotes Inermis has large canines.

Michie's Deer has large canines.

A few deer have no canines at all.

PERISSODACTYLES *(odd toed).*

Premolars and molars form an unbroken series and are almost equally complex.

Study the pattern on the molars of the **Tapir**, **Rhinoceros**, and **Horse**.

Study the "**Mark**" on the **Horse's** incisor in the case in the next alcove.

The **Stallion** has a small canine, in the **Mare** the canine is rudimentary.

SUBUNGULATA.

HYRACOIDEA.

Hyrax . . . is rodent-like in general form, but it has molars like the rhinoceros and an upper second incisor, which is lost early, and the two lower incisors are not of persistent growth and bite on the upper gum. The first upper incisor is of persistent growth.

PROBOSCIDEA.

Elephant . . . is diphyodont, heterodont $\begin{smallmatrix} 1 & 0 & 3 \\ 0 & 0 & 3 \end{smallmatrix}$ in each set, the milk molars and permanent molars erupt one after the other into the same situation; they are hypsodont, poly-lophodont, and composed of cementum, enamel and dentine.

The tusk is of persistent growth, tipped with enamel, covered with cementum, and the dentine is less calcified, apt to contain interglobular spaces, and the tubules have well marked secondary curvatures.

Mastodon . . had brachyodont teeth and tusks in both jaws.

Dinotherium had tusks in the lower jaw only.

UNGULATA

UNGULATA VERA

Diphyodont; heterodont; enamel, hard dentine, cementum. Brachyodont and hypsodont; bunodont, selachodont and lophodont. VEGETABLE DIET: 1. LONG NARROW ARCH. 2. REDUCTION OF FRONT TEETH. 3. SUPPRESSION OF CANINES. 4. DEVELOPMENT OF CHEEK TEETH. 5. GLOBULAR GONDYLE.

ARTIODACTYLES

Premolars differ markedly from true molars (similiar). Bunodonts. Sheep and Colobid family. The unguals are not fused (no manus). The unguals are of persistent growth. No upper incisors. The feet are hooved; the feet only. have large central persistent growing canines. have no canines; hypsodont teeth and thick cementum over the enamel.

PERISSODACTYLES

Premolars and molars form an endodontic series and are almost equally complex. Study the position of the center of the jaw, Bunodonts and Horses. Study the "Mark" on the horse's lower jaw in the next lesson. The Station has a small volume in the file the center is rudimentary. The feet have an ungula on all toes. Sheep, Oxen, Antelope, Giraffe, Deer, Hares, Rabbits, Squirrels, Mice, Rats, etc.

SUBUNGULATA

HYRACOIDEA

Hyxes. is intermediate in general form, but it has molars like the bunodonts and an upper incisor which is lost early, and the two lower incisors are not of persistent growth, and like on the upper jaw. The first upper incisor is of persistent growth.

PROBOSCIDEA

Elephant. is diphyodont heterodont; it is like the ungulate and persistent molars with an arch like the ungulate; they are hypsodont, very hypsodont, and composed of cementum, enamel and dentine. The trunk is of persistent growth, tipped with cementum, covered with keratin, and the trunk is less developed and contains interdigital spaces, and the tubular part will contract considerably. Elephant has brachyodont teeth, and the tubular part will contract and take in the trunk part.

RODENTIA.

Almost monophyodont, heterodont, $\frac{1013}{1013}$, persistent growing incisors (enamel on the front only), hypsodont or persistent growing molars, grooved at the sides, condyle long antero-posteriorly.

Hydromys	$\frac{1002}{1002}$, few teeth.
Agouti	has non-persistent growing molars.
Coast Rat	has non-persistent growing molars.
Capybara	has persistent growing molars and a large 3rd molar.
Beaver	has persistent growing molars.
Hare and Rabbit	have $\frac{2022}{1022}$, no pattern in the enamel; many milk teeth; some lateral movement to the jaw; 2 upper incisors.

COMPARE THE PATTERN IN THE ENAMEL OF:—

MANATEE, MAN, RABBIT, BEAVER, SQUIRREL, PORCUPINE, RAT, JERBOA MARSUPIALS.

CARNIVORA.

Diphyodont, heterodont, $\frac{3131}{3121}$

CARNIVOROUS DIET

1. INCISORS, 6 IN A STRAIGHT ROW.
2. CANINES, LARGE AND WIDE APART.
3. PREMOLARS, SMALL, INCREASING IN SIZE BEHIND AND BLADE-LIKE.
4. MOLARS, RUDIMENTARY.
5. $\frac{pm_1}{m_1}$, "SECTORIAL" OR "CARNASSIAL" TEETH.
6. ARCH SQUARE, AND ZYGOMA BROAD.
7. CONDYLES FORM A PURE HINGE JOINT.

$\left(\frac{3131}{3121}\right)$

TERRESTRIAL.

CELURIDEA (*cat-like*). Sharp "carnassials," rudimentary molars.

Tiger and Cat	Typical carnivora.
Hyæna	has short stout teeth.
Aard-Wolf	has rudimentary premolars and molars.
Binturong and Herpestes	Herbivorous diet and Insectivorous diet.

CYNOIDEA (*dog-like*). Sharp "carnassials," fairly good molars.

Wild Dog	has no lower 3rd molar.
Common Dog	$\frac{3142}{3122}$ typical mixed feeder. Milk "carnassials" $\frac{dm_3}{dm_4}$
Otocyon	has 48 teeth (4 molars).

ARCTOIDEA (*bear-like*). No "carnassials," broad topped molars.

Coati and Suricate	have flattened canines and blunt molars.
Bear	Typical herbivorous carnivora.

Sloth Bear, Otters, Badgers, Polecats, Glutton, &c.

AQUATIC. Degenerate carnivorous forms. Rudimentary milk teeth.

Otaria (sea lions)	A fairly carnivorous type.
Phoca (common seal)	A less carnivorous type, more homodont.
Walrus	has large persistent growing canines.

INSECTIVORA.

Diphyodont, heterodont, $\frac{3143}{3143}$, small canines, MANY CUSPS on the molars.

Galeophticus	has lower comb-like incisors.
------------------------	-------------------------------

W PATTERN.

Mole (<i>talpa</i>)	(Draw a diagram.)
Hedgehog (<i>erinaceus</i>)	is typical.
Shrew (<i>sorex</i>)	has very large incisors of peculiar shape, and tubular enamel.
Tupaia	

V PATTERN.

(Less specialised).

Potomogale; Centetes; Hemicentetes.

CHIROPTERA.

Diphyodont, heterodont, large canines.

INSECTIVOROUS (Similar to W pattern Insectivora, but larger canines).

Common Bat.	
Vampire	has rudimentary back teeth and hook-like milk teeth.

FRUGIVOROUS. Hollow flat-topped molars.

Pteropus.
Cephalotes peronii.
Cynonycteris dupreana.

RODENTIA

Almost monophodont, heterodont, ¹¹¹¹ ₁₀₁₁ persistent growing incisors (enamel on the front only), hypsodont or persistent growing molars, groove at the sides, condyle long antero-posteriorly.

Hydrax
Agouti
Coati cat
Capybara
Beaver
Rat and Squirrel

has two persistent growing incisors
has two persistent growing incisors
has persistent growing molars and a large 3rd molar
has persistent growing molars
has 22 incisors in the lower; many teeth, some lateral movement to the jaw; 2 upper incisors

COMPARE THE PATTERN IN THE ENAMEL OF: MANATEE, RABBIT, BEAVER, SQUIRREL, PORCUPINE, RAT, SERRA MARRUJALE.

CARNIVORA

Diphodont heterodont ¹¹¹¹ ₁₁₁₁

CARNIVOROUS DIET

1 INCISORS IN A STRAIGHT ROW.
2 CANINES LARGE AND WIDE APART.
3 REMOVAL SMALL, INCREASING IN SIZE BEHIND AND BLADE-LIKE.
4 MOLARS SUPPLEMENTARY.
5 RECTANGULAR OR "CARABASSIAL" TEETH.
6 ARCH SQUARE AND ZYGOMA BROAD.
7 CONDYLE FROM A PURE HINGE JOINT.

TERRSTRIAL

CELVORZA (fox-like) Sharp "carabassial", rudimentary molars.
Tiger and Cat
Raccoon
Weasel
Badger
Mongoose and Herpetes
GYNORZA (dog-like) Sharp "carabassial", fairly good molars.
Wolf dog
Common dog
Gorilla
AROTORA (sheep-like) No "carabassial", broad topped molars.
Goat and Squirrel
Rat

Sharp "carabassial", rudimentary molars.
has two large teeth
has rudimentary premolars and molars
has two large teeth and incisors that
has no teeth at all
typical wolf-like teeth, but "carabassial"
has no teeth (4 molars)

Sharp "carabassial", broad topped molars.
has broad canines and thin molars
typical herbivorous canines
both bear, deer, badger, polecat, gibbon, etc.

AQUATIC

Degenerate carnivorous forms. Rudimentary milk teeth.

1 large mammalian type
2 few canines, large nose, broadhead
has large prominent, strong canines

Quail (sea horse)
Beaver (sea horse)
Walrus

INSECTIVORA

Diphodont heterodont ¹¹¹¹ ₁₁₁₁ small canines, MANY CUSPS on the molars.
Dipodops

W PATTERN

W PATTERN

Wife (spike)
Belated (inverted)
Spike (spike)
Tooth

(from a squirrel)
a typical
has very large bulges of enamel, sharp and tubular enamel

V PATTERN

V PATTERN (Less specialized)

Phenacops: Canines: heterodont
Diphodont heterodont, large canines.

CHIROPTERA

INSECTIVOROUS (similar to W pattern insectivora, but larger canines).
Phenacops
Phenacops
Phenacops
Phenacops
Phenacops

has rudimentary milk teeth and tooth-like milk teeth
Hollow bell-topped molars
Phenacops
Phenacops
Phenacops
Phenacops
Phenacops

PRIMATES. Diphyodont, heterodont $\begin{matrix} 2 & 1 & 3 & 3 \\ 2 & 1 & 3 & 3 \end{matrix}$

LEMURS.

- Slow Lemur Typical Lemur; $\begin{matrix} 2 & 1 & 3 & 3 \\ 2 & 1 & 3 & 3 \end{matrix}$
- Ruffed Lemur " "
- Indri has only one lower incisor.
- Aye-Aye (cheiromys) A rodent type. Persistent growing incisors; but milk teeth $\begin{matrix} 2 & 1 & 2 \\ 2 & 1 & 2 \end{matrix}$

SIMIADÆ.

NEW-WORLD (platyrrhine). $\begin{matrix} 2 & 1 & 3 & 2 \\ 2 & 1 & 3 & 3 \end{matrix}$

Hapalidæ.

Marmosets have only two molars.

Cebidæ.

Ateles and Capuchin Gradual change from incisors to molars.

OLD-WORLD (catarrhine). Same formula as man.

Baboons Peculiar lower first premolars.

Chaema and Rhesus Baboons.

Anthropoid Apes.

- Orang has very long teeth.
- Gorilla Late eruption of canines.
- Chimpanzee is the most like man.

- DIFFER FROM MAN:**—1. **PROGNATHOUS** (late closure of suture).
 2. **SQUARE JAWS** (molars converging behind).
 3. **MEGADONT.**
 4. **LATERALS CANINIFORM; DIASTEMA.**
 5. **CANINES, SEXUAL, LARGE, LATE ERUPTED.**
 6. **PREMOLARS, UPPER THREE, LOWER TWO-ROOTED.**
 7. **MOLARS, INCREASE IN SIZE BACKWARDS.**

MAN.

$$\text{Gnathic Index} = \frac{\text{B.A.} \times 100}{\text{B.N.}}$$

$$\text{Dental Index} = \frac{\text{L. of T.} \times 100}{\text{B.N.}}$$

LEARN THE ANATOMY OF EACH HUMAN TOOTH IN ABSOLUTE DETAIL.
COMPARE THE MOLARS OF APES, ABORIGINES, NEGROES, AND EUROPEANS.

MARSUPIALS. Diphyodont? heterodont $\begin{matrix} 3 & 1 & 3 & 4 \\ 3 & 1 & 3 & 4 \end{matrix}$; tubular enamel.

DIPROTODONTS. $\begin{matrix} 3 \\ 1 \end{matrix}$ incisors, small canines, molars ridged.

- Kangaroo Rats Herbivorous; $\frac{1}{4}$ persistent growth; pm₄ large.
- Cast of Thalacoleo is herbivorous, not carnivorous.
- Kangaroos Herbivorous; $\frac{1}{4}$ persistent growth, pm₄ replaces dm₄; pm₃ is shed later on.
- Australian Opossum is herbivorous.
- Phaseolaretos Cinereus is rodent-like.
- Wombat is rodent-like; all the teeth are of persistent growth; no tubes in the enamel; cementum grows all round the teeth. Has $\begin{matrix} 1 & 1 & 1 \\ 0 & 1 & 1 \end{matrix}$ MILK teeth.
- Tarsipes has rudimentary molars.

POLYPROTODONTS. $\begin{matrix} 4 \\ 3 \end{matrix}$ incisors, good canines, molars tuberculated.

- Thalycine is dog-like; differences?
- Tasmanian Devil is carnivorous.
- Dasyurus Viverinus is insectivorous.
- Azar's Opossum is insectivorous.
- Myrmecobius has fifty-four teeth; many milk teeth formed but unerupted.

PRIMATESS. Diphyodont, heterodont

LEMURS

Two Jaws
Killed Jaws
Isthm
A-to-Ate (Incomple)

Typical Lemur
has only one jaw below

A recent type. Evolutionary growing factors, but still with

SIMIAE

NEW WORLD (Platyrrhini)
Karyoid
Karyotype
Cebus

have only two molars

tribes change into primates in tooth

OLD WORLD (Catarrhini)

Same formula as man
Cebus
Cebus and Rhinoceros

Same formula as man

has two long teeth
last region of molar
in the end like man

Antropoid
Orang
Gorilla
Chimpanzee

- DIFFER FROM MAN—
1. PROGNATHOUS (the chin of apes)
 2. SQUARE JAW (the jaw extending behind)
 3. MEGADONT
 4. LATERAL GANGLION, DIASTEMA
 5. GANGLION SEXUAL LARGE LATE ERUPTED
 6. PREMOLAR AND UPPER THREE LOWER TWO-ROOTED
 7. MOLAR INCREASE IN SIZE BACKWARDS

MAN

Gnathic Index --
Dental Index --

LEARN THE ANATOMY OF EACH HUMAN TOOTH IN ABSOLUTE DETAIL.
COMPARE THE MOLARS OF APES, ANTHROPOID, NEGROES, AND EUROPEANS

MARSUPIALS. Diphyodont? heterodont? tubular enamel.

DIPHYODONTS

Kangaroo Rat
Gut of Marsupial
Kangaroo
Australian Quokka
Pseudois Gannoni
Wombat

Incisors small canine, molar ridged.
Heterodont; persistent growth; long jaws.
In heterodont and carnivorous.
Heterodont; persistent growth; long, replace due to, replaced later on.

is similar like. On the teeth are of persistent growth, no tubes in the
canine; molar grows all round the tooth. The $\frac{1}{2}$ size tooth.
has rudimentary molars

POLYPHYODONTS

Thylacine
Tasmanian Devil
Diprotodon
Aust. Quokka
Wombat

Incisors, good canines, molar tuberculated.

the first tooth, many will teeth turned but unpaired.

EDENTULOUS.

Adult Sturgeon, Pipe-fish, Hippocampus.
 Toad.
 Echidna.
 Manis, Mutica, Rhytina, Mystacoceti.
 Birds.
 The Narwal, Sword-fish, and Carp have edentulous MOUTHS.

TEETH OF PERSISTENT GROWTH.

Pristis (dermal spines).
 Dicynodon (canine tusks only).
Canines of Suina, Tragulidæ, and Cervidæ.
Canines and Incisors of Hippopotamus.
Upper Incisors of Hyrax, Elephant, Hysiprymnus.
Lower Incisors of Kangaroo, Hysiprymnus.
Upper and Lower Incisors of Rodents, Aye-Aye.
Molars of many Rodents.
 All the **Teeth** of Edentata, Dugong, Wombat.

VERTICAL SUCCESSION OF TEETH.

Lamprey, File-fish, Wrasse (pharyngeal teeth), Pseudo-scarus, Sargus, Gymnodonts.
 Most Reptiles.
 Ichthyornis and Hesperornis.

RUDIMENTARY TEETH EXIST IN:—

Bdellestoma, Myxine, Sword-fish, Larval Sturgeon.
 Rachiodon (and Elachistodon). (DASYPELTIS, new name for Rachiodon).
 Ornithorhynchus and Mystacoceti.
MILK TEETH of Orycteropus, Mole, Shrews, Guinea-pig, Bats, Seals.
SECOND SET of Odontoceti.
Tusks of FEMALE Narwal, Dugong.
Canines of FEMALE Suina, Tragulidæ, Pecora, Deer, Mare.
INCISORS of Rhinoceros, 6-banded Armadillo, Manatee, Narwal, Petrogale.
UPPER CANINES of Kangaroo.
MOLARS of Tarsipos, Vampire, Aard-wolf, and True Carnivora.
1ST PREMOLAR of Horse, Bear, Pig.

HORNY TEETH, OR PLATES, EXIST IN:—

Lamprey, Myxine, Bdellestoma.
 Tadpole, Turtle, Tortoise, Dicynodon (?), Rhamphorhynchus, Pteranodon (?).
 Merganser.
 Ornithorhynchus.
 Dugong, Manatee, Rhytina.

SEXUAL TEETH ARE FOUND IN:—

Raia Clavata.
 Narwal, Ziphoid cetaceans.
 Dugong.
 Suina, Tragulidæ, Camel, Hydropotes, Musk-deer, Stallion, Muntjak, Elaphodus.
 Monkey.

GLOSSARY.

Acro-dont	Eel.
Pleuro-dont	Iguanodon.
Haplo-dont	Dolphin.
Proto-dont	Dromotherium.
Tricono-dont	Triconodon (Leopard Seal).
Tritubercular	Spalacotherium.
Buno-dont	Pig, Man.
Seleno-dont	Sheep.
Lopho-dont	Elephant.
Bilopho-dont	Tapir.
Brachyo-dont	Pig, Man, Mastodon.
Hypso-dont	Horse, Elephant.
Homo-dont	Dolphin.
Hetero-dont	Pig, Man.
Monophyo-dont	Dolphin.
Diphyo-dont	Pig, Man.
Polyphyo-dont	Shark.
Micro-dont	Anglo-Saxon.
Meso-dont	Nigger.
Mega-dont	Aborigines, Monkeys.
Orthognathous	Europeans.
Mesognathous	
Prognathous	Horse.

EDENTULOUS

The absence of teeth, and may be congenital or acquired.

TEETH OF PERSISTENT GROWTH

Teeth which continue to grow throughout life, such as the teeth of rodents and some marsupials.

VERTICAL SUCCESSION OF TEETH

The process by which one tooth is replaced by another in the same position.

RESIDUARY TEETH EXIST IN--

In the lower jaw of some mammals, such as the dog and cat, where the upper teeth are replaced by a second set of lower teeth.

HORNY TEETH OR PLATES EXIST IN--

In the jaws of some mammals, such as the walrus and manatee, where the teeth are replaced by horny plates.

SEXUAL TEETH ARE FOUND IN--

In the jaws of some mammals, such as the seal and walrus, where the teeth are replaced by horny plates.

GLOSSARY

A two-column glossary listing dental terms and their definitions. The text is very faint and difficult to read, but appears to contain a comprehensive list of terms related to the preceding sections.

PREPARATION OF HARD TISSUES.

1. **Saw** into thin slices. (Cut enamel with a diamond disc.)
2. Grind on a **carborundum wheel**, as thin as possible.
3. Grind between two bits of **ground plate glass**, with pumice and water.
4. **Wash**.
5. **Dry lightly** on the hand.
6. Mount in warm **hard Canada balsam**.

PREPARATION OF SOFT TISSUES.

1. **Fix** in Muller's fluid or corrosive sublimate, &c.
2. **Harden** in 80 % alcohol.
3. **Dehydrate** in absolute alcohol.
4. **Stain** in borax carmine, &c.
5. **Clear** in oil of cloves, &c.
6. **Imbed** in gum mucilage, paraffin, celloidin.
7. **Cut**.
8. **Mount** in Canada balsam or glycerine jelly, &c.

If preferred, the sections may be **stained, dehydrated and cleared**, after being **cut**, instead of before.

PREPARATION OF HARD AND SOFT TISSUES TOGETHER.

WEIL'S PROCESS.

1. Saw a fresh tooth into four pieces, under water.
2. **Fix** in a saturated sol. of HgCl_2 about 4 hours.
3. **Wash** in running water " 2 "
4. **Harden** in 30 % alcohol " 12 "
5. " in 50 % " " 12 "
6. " in 70 % " " 12 "
7. " in 90 % " and a few drops of tr. of iodine " 12 "
8. **Stain** in alcoholic borax carmine " 3 weeks.
9. Fix the stain with 70 % alcohol and $\frac{1}{4}$ % HCl " 12 hours
10. **Dehydrate** in 90 % " " 24 "
11. " in absolute " " 24 "
12. **Clear** in oil of cloves " 6 "
13. Wash in xylol.
14. Soak in **chloroform** " 1 day
15. **Imbed** in a weak sol. of Canada balsam " 2 days.
16. " in a strong " " " " 2 "
17. " in thick Canada balsam at 70° C. " 1 day.
18. " in " " 90° C. " 2 days.
19. **Grind** when cool and brittle.
20. **Mount** in Canada balsam.

PREPARATION OF HARD TISSUES

1. Saw the thin slice (Cut round with a diamond disk)
2. Load on a carbonium wheel, as thin as possible
3. Press between two bits of ground plate glass, with pressure and water
4. Wash
5. Dry lightly on the face
6. Mount in water-hard Canada balsam

PREPARATION OF SOFT TISSUES

1. Fix in Muller's fluid or appropriate substitute for 24 hours
 2. Harden in 70% alcohol
 3. Dehydrate to absolute alcohol
 4. Stain in basic carmalum, etc.
 5. Clear in oil of cedar, etc.
 6. Imbed in gum mastic, paraffin, celloidin
 7. Cut
 8. Mount in Canada balsam or appropriate resin, etc.
- In practice the sections may be stained, dehydrated and cleared, after being cut, instead of before.

PREPARATION OF HARD AND SOFT TISSUES TOGETHER

WEIR'S PROCESS

1. Saw a thick slice into four pieces, under water
2. Fix in a saturated solution of HgCl₂
3. Wash in running water
4. Harden in 70% alcohol
5. Dehydrate in 70% alcohol
6. Dehydrate in 100% alcohol
7. Clear in cedar oil or cedar
8. Stain in alcoholic borax carmalum
9. Fix the sections in 100% alcohol and 2 HCl
10. Dehydrate in 70% alcohol
11. Dehydrate in absolute alcohol
12. Clear in cedar oil
13. Wash in cedar
14. Fix in chloroform
15. Imbed in a resin and in Canada balsam
16. Clear in cedar
17. Fix the sections in cedar
18. Clear in cedar
19. Grind when cut and finish
20. Mount in Canada balsam

HOPEWELL SMITH'S PROCESS.

1. Remove the apex from a fresh tooth.
2. **Fix** in Muller's fluid about 3—4 weeks.
3. **Harden** in 84 % alcohol „ 20 days.
4. Wash in normal salt solution (.6 %), dry and protect the soft parts with collodion.
5. **Decalcify** in 12 c.c. of 10 % HCl „ 15 hours.
6. „ add 1.5 c.c. pure HNO₃ „ 33 „
7. „ add 1.5 c.c. pure HNO₃ again „ 27 „
8. **Neutralise** in lithium carbonate (6 grs.—1 oz.) „ $\frac{1}{2}$ „
9. Wash in distilled water.
10. **Imbed** small pieces in gum mucilage „ 15 „
11. **Freeze, cut,** and float off sections on water, stain.
12. **Dehydrate, clear,** and mount.

MULLER'S FLUID:—

BICHROMATE OF POTASH	2 $\frac{1}{2}$ parts.
SULPHATE OF SODA	1 part.
WATER	100 parts.

CHROMIC ACID PROCESS.

1. Place the tooth in half a pint of—

Chromic acid	$\frac{1}{4}$ volume.
Nitric acid	$\frac{1}{2}$ „
Water	100 volumes.
2. Change frequently. 3—4 weeks.
3. Wash thoroughly.
4. **Imbed** in paraffin, cut, stain, &c.

IMBEDDING.

GUM MUCILAGE IMBEDDING.

1. **Fix** in Muller's fluid 3—4 weeks.
2. **Wash** in water.
3. **Imbed** in—Gum mucilage 5 parts.
Syrup 4 „ 15 hours.
4. Place on a microtome and cover with mucilage.
5. **Freeze, cut,** and float off sections on water.
6. **Stain, dehydrate, clear,** and mount.

HORSWELL SMITH'S PROCESS

1. Remove the wax from a fresh block.
2. Fix in Miller's fluid.
3. Harden in 95% alcohol.
4. Wash in running water (10 min) and prevent the wax parts with collodion.
5. Decalcify in 10% of 10% HCl.
6. Add 1-2 cc pure HNO₃.
7. Add 1-2 cc pure HNO₃ again.
8. Neutralize in running water (10 min).
9. Wash in running water.
10. Embed in 10% paraffin in gum benzoin.
11. Freeze, cut, and stain as follows in water bath.
12. Dehydrate, clear, and mount.

MULLER'S FLUID

- | | |
|-----------|-----------------------|
| 100 parts | WATER |
| 1 part | SULPHATE OF SODA |
| 1/2 part | BICARBONATE OF POTASH |

CHROMIC ACID PROCESS

1. Fix the wax in half 2 parts of Chromic acid 1 volume.
2. Wash in running water.
3. Embed in paraffin in gum benzoin.
4. Freeze, cut, and stain as follows in water bath.

IMBEDDING

GUM MUCILAGE IMBEDDING

1. Fix in Miller's fluid.
2. Wash in water.
3. Embed in 10% paraffin in gum benzoin.
4. Freeze, cut, and stain as follows in water bath.
5. Dehydrate, clear, and mount.

COLLODION IMBEDDING (for large objects).

1. **Dehydrate** in absolute alcohol.
2. Soak in a mixture of equal parts of **alcohol** and **ether**.
3. Place in a very **thin** solution of **collodion**.
4. Place in a **thick** " " "
5. Allow the solution to evaporate slowly.
6. Remove the object to 30 % **alcohol** to harden.
7. **Cut** with a microtome.
8. **Stain** and **dehydrate**.
9. **Clear** in cedar oil (**not** oil of cloves).
10. **Mount**.

The time taken will depend on the size and permeability of the object. It is better, when possible, to make cuts in the specimen to hasten penetration.

PARAFFIN IMBEDDING (for small objects and very thin sections).

1. **Dehydrate**.
2. **Clear** in cedar oil.
3. Place in **melted paraffin** (45° C.) still saturated (1 hr.).
4. **Cool** rapidly. (To prevent crystallisation.)
5. Mount on a microtome and **cut**.
6. Warm and wash out paraffin with **naphtha**.
7. **Stain, clear, mount**.

In either method the object may be stained in mass before imbedding, if preferred.

STAINS.**ALCOHOLIC BORAX CARMINE** (for staining in bulk).

1. Place in the stain till saturated 2—4 weeks.
2. Place in acid alcohol to fix the stain 12 hours.
3. Dehydrate in 90 % and 100 % neutral alcohol 12 hours each.

ACID ALCOHOL:—70 % ALCOHOL AND 2 DROPS HCl TO A TEST TUBE FULL.

SILVER NITRATE.

1. Wash the fresh tissues in distilled water.
2. Place in 1 % AgNO_3 in the sunlight, till of a whitish-grey colour.
3. Wash and mount at once.

COLLOIDION IMBEDDING (The Jaffe Method)

1. Dehydrate in ascending alcohols.
2. Clear in cedar oil.
3. Place in a very thin section of collodion.
4. Place in a thick layer of collodion.
5. Allow the section to dry on a slide.
6. Immerse the object in 30% alcohol to remove the collodion.
7. Cut with a microtome.
8. Stain with delustrant.
9. Cover with water till most of the alcohol is removed.
10. Mount.

The time when the object is in the alcohol and the percentage of the alcohol is of great importance. It is better when possible to use a series of alcohols to remove the alcohol.

PARAFFIN IMBEDDING (The Small Object and Very Thin Sections)

1. Dehydrate.
 2. Clear in cedar oil.
 3. Place in melted paraffin (56° C) till saturated (1 to 2 hours).
 4. Cool rapidly (To prevent crystallization).
 5. Mount in a microtome and cut.
 6. Wash and wash out paraffin with xylene.
 7. Stain, clear, mount.
- In order to make the object more brittle before imbedding it is preferred to use a series of alcohols to remove the alcohol.

STAINS

ALCOHOLIC BORAX-CARMEUM OR BORAX-ORANGE G

1. Place in the stain till saturated.
 2. Place in cedar oil till saturated.
 3. Immerse in 30% alcohol and 10% cedar oil.
- ADD ALCOHOL—50% ALCOHOL AND 5 DROPS HCI TO A TEST TUBE FULL.
- 12 hours
12 hours

SILVER NITRATE

1. Wash the fresh tissues in distilled water.
2. Place in 1% AgNO₃ in the solution till the silver nitrate is removed.
3. Wash and embed as usual.

HÆMATOXYLENE.

1. Place the section in a dark sol. of hæmat. ¼ hour.
2. Wash well in water.
3. Dehydrate in absolute alcohol 10 min.
4. Clear in cedar oil and mount.

To counter-stain with **eosin**, add eosin to the absolute alcohol used for dehydrating.

MUMMERY'S IRON AND TANNIN.

1. Wash the sections in water.
2. Place in liquor ferri perchloridi 24 hours.
3. Wash quickly and thoroughly.
4. Place in tannic acid (2 grs.—6 c.c. of water) 5—10 min.
5. Wash in water, dehydrate, clear, and mount.

GOLGI'S METHOD.

1. Place the sections in a mixture of—
 - 2 % sol. potassium bichromate 8 parts.
 - 1 % sol. osmic acid . . . 2 „ 24 hours.
2. Remove to 0.5 % AgNO₃ (in the dark) 1 day.
3. Dehydrate, clear, and mount in gum dammar.

UNDERWOOD'S GOLD CHLORIDE. WEN'S LINES

1. Grind section.
2. Wash in 1 % Na₂ CO₃.
3. Neutral 1 % sol. of AuCl (in the dark) 1 hour.
4. Wash in water („ „ „) 10 min.
5. Warm 1 % sol. of formic acid („ „ „) 1 hour.
6. Wash in cold water.
7. Dry and mount in glycerine jelly.

TO STAIN BACTERIA.

1. Place the sections in a strong alcoholic sol. of **gentian violet** 3 min.
2. Wash in **Gram solution** 3 „
3. Wash in absolute alcohol till differentiated.
4. Clear and mount.

GRAM SOLUTION:—

IODINE 1 part.
 POTASSIUM IODIDE 2 parts.
 WATER 300 „

HEMATOXYLINE

1. Place the section in a flask of running water.
 2. Wash well in water.
 3. Dehydrate in absolute alcohol.
 4. Clear in cedar oil and mount.
- To counter-stain with eosin, add eosin to the absolute alcohol used for dehydrating.

10 min.

5-10 min.

MUMMERY'S IRON AND TANNIN

1. Wash the sections in water.
2. Place in clear ferric perchlorate.
3. Wash quickly and thoroughly.
4. Place in iron salt (2 grs. - 6 cc. of water).
5. Wash in water, dehydrate, clear, and mount.

24 hours

1 hour

GOLGI'S METHOD

1. Place the sections in a solution of—
2. 1% sol. potassium bichromate 4 parts
3. 1% sol. osmic acid 2
4. 1% sol. potassium dichromate (in the dark) 1
5. Dehydrate, clear, and mount in gum dammar.

UNDERWOOD'S GOLD CHLORIDE

1. Grind section.
2. Wash in 1% H₂O₂.
3. Neutral 1% sol. of AuCl₃ (in the dark).
4. Wash in water.
5. Warm 1% sol. of tartaric acid.
6. Wash in cold water.
7. Dry and mount in glycerine jelly.

1 hour

10 min.

1 hour

TO STAIN BACTERIA

1. Place the sections in a strong alcoholic sol. of gentian violet.
2. Wash in Gram solution.
3. Wash in absolute alcohol till differentiated.
4. Clear and mount.

1 min.

GRAM SOLUTION

- 100ME IODINE
- POTASSIUM IODIDE 2 parts
- WATER 300

TO SHOW :—**ENAMEL PRISMS.**

Grind and mount unstained.

TRANSVERSE STRIÆ OF ENAMEL PRISMS.

1. They may be slightly seen in ordinary ground sections.
2. Grind a section and wash it in weak HCl, and stain with carmine.

BROWN STRIÆ OF RETZIUS.

An ordinary ground section.

DENTINAL FIBRILS.

1. Weil's process.
2. Hopewell Smith's process.

DENTINAL TUBES.

1. Unstained ground sections.
2. Underwood's gold chloride.

DENTINAL SHEATHS. (Sheaths of Neumann).

1. Golgi's method.
2. Grind a section and wash in HCl (tubes only remain).

INTERGLOBULAR SPACES AND OWEN'S LINES.

1. Weil's process.
2. Underwood's gold chloride.

VASO-DENTINE AND OSTEO-DENTINE.

1. Weil's process.
2. Chromic acid process.

PULP CELLS. (*Odontoblasts.*)

1. Weil's process.
2. Hopewell Smith's process.

NERVES OF THE PULP.

Mummery's iron and tannin stain.

ENCAPSULED LACUNÆ. (*Use a horse's tooth.*)

Stain a ground section with carmine after partially decalcifying in HCl.

SHARPEY'S FIBRES.

Same as for encapsuled lacunæ. •

ENAMEL PRISMS

Ground and mounted sections

TRANSVERSE STRIÆ OF ENAMEL PRISMS

1. They may be slightly seen in ordinary ground sections
2. Ground a section and wash it in weak HCl and stain with carmalum

BROWN STRIÆ OF RETZIUS

1. Ordinary ground sections

DENTINAL FIBRILS

1. Weir's process
2. Havers's method

DENTINAL TUBES

1. Tinted ground sections
2. Havers's method

DENTINAL SHEATHS (Specialty of Retzius)

1. Dufy's method
2. Ground a section and wash in HCl (before only section)

INTERLOBULAR SPACES AND OWEN'S LINES

1. Weir's process
2. Havers's method

VASO-DENTINE AND OSTEO-DENTINE

1. Weir's process
2. Chromic acid process

PULP CELLS (Anthrone)

1. Weir's process
2. Havers's method

NERVES OF THE PULP

Havers's method

ENCAPSULATED LACUNÆ

Stain a ground section with carmalum after fasten with benzidine in HCl

SHARPEY'S FIBRES

Stain for encapsulated lacunæ

NASMYTH'S MEMBRANE.**CELLULAR STRUCTURE.**

1. To show nuclei.

Remove from tooth with HCl and phloroglucin, stain in Erlich's acid HEMATOXYLENE, wash and mount in Farrant solution.

2. To show outline of cell.

Remove with HCl, and stain with NITRATE OF SILVER.

POSITION.

Grind a section, mount on a slide, and wash with HCl, stain with carmine.

PERIOSTEUM AND GUM.

1. Chromic acid method.
2. Hopewell Smith's method.

DEVELOPING TEETH.

Chromic acid method, carmine stain, and paraffin imbedding.

CARIES OF THE ENAMEL.

Ordinary ground section.

CARIES OF THE DENTINE.

Weil's method.

GERMS IN THE TUBES.

Break off the enamel from a carious tooth.
Wash in salt sol. and remove soft part with one cut.
Place in gum mucilage (15 hrs.).
Freeze and cut.
Stain the sections by Gram's method.
Clear and mount.

TRANSLUCENT ZONE.

1. Weil's method.
2. Underwood's gold chloride.

NASMYTH'S MEMBRANE

CELLULAR STRUCTURE

1. To stain nuclei
 However, this reacts with HCl and hydroxylic stain in Ehrlich's acid fastness, iron and osmium
 in formal solution
 2. To stain outline of cell
 Iodine with HCl and stain with mixture of water

POSITION

Found in various places on a slide, and stain with HCl stain with osmium

PERIOSTEUM AND GUM

- 1. Unstained and method
- 2. Haversian Canal's method

DEVELOPING TEETH

Various and method, osmium stain, and possible including

CARRIES OF THE ENAMEL

Various stained sections

CARRIES OF THE DENTINE

Walt's method

GERMS IN THE TUBES

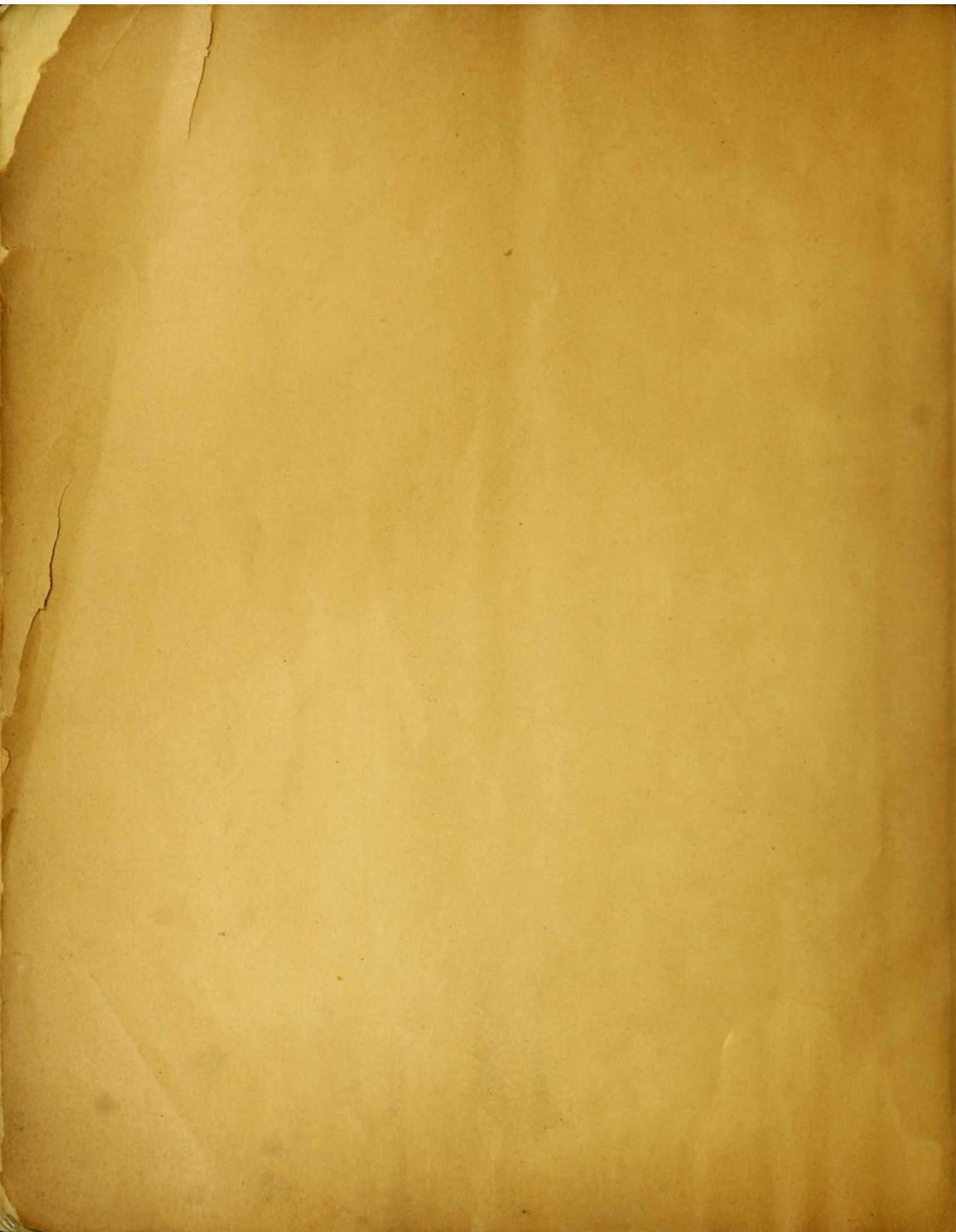
Stain of the enamel from a carious tooth
 Walt's in cell and osmium and fast with iron
 Iodine in some sections (25 part)
 Iodine and fast
 stain the sections by Gram's method
 Gram and osmium

TRANSLUCENT ZONE

Walt's method
 Iodine and osmium, cell structure

SOUTHERN CROSS

SUPERFINE



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