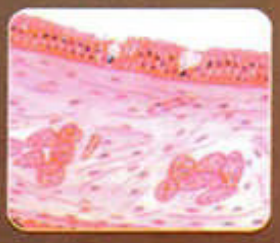
Essentials of Oral Biology

Second Edition

Oral Anatomy, Histology, Physiology and Embryology



Maji Jose

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Oral Biology

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Foreword

Oral biology, which includes oral anatomy, histology, physiology and embryology is one of the most important and useful subjects among the various basic science subjects, in the dental curriculum. Understanding of this subject widens the mental comprehension and strengthens the basic concepts of different dental science specialties. A thorough knowledge of this subject is sure to mould a dental student into an effective and efficient clinician.

I am happy that Dr Maji Jose is bringing out a textbook *Essentials of Oral Biology* (Oral Anatomy, Histology, Physiology and Embryology) for students pursuing dentistry. Visualizing the integrated perspective of the subject, she has been successful in gathering together the diverse elements of oral biological sciences, which in the past had been scattered throughout many textbooks. I am sure that this book will be useful for dental students to improve their knowledge in oral biological sciences as well as to help them to confidently face the exam.

I hope that this work will receive the deserved attention and encouragement from both dental students and teachers.

I wish the author and this book all success.

BH Sripathi Rao MDS
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Former Executive Committee Member;
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Preface to Second Edition

The textbook *Essentials of Oral Biology* presents all subsections of Oral Biology in single book, described in five sections: Oral Embryology, Oral Histology, Oral and Dental Anatomy, Oral Physiology and Allied Topics. This text provides a comprehensive coverage of all the topics included in the curriculum specified by Dental Council of India and various Indian universities. Different topics are dealt in detail in 50 chapters with flowcharts, tables and color diagrams to make learning more simple and pleasant. This book also includes an additional section on expected questions from each chapter, commonly asked in examinations of various Indian universities, to assist the students in examination preparations.

This book has been designed in a way to keep the characteristics of a standard textbook for undergraduate students. The topics are explained in simple and lucid language. Concepts are presented in a simple and clear manner to help an undergraduate student develop a comprehensive knowledge in this basic science subject which makes a sound base for learning pathologic basis of diseases.

I am gratified that original edition has received a good response. A positive feedback on the first edition of the book and various encouraging comments received from students and teachers, who have used the book, has encouraged me to come out with second edition. The second edition is a revised and updated version with flowcharts, more tables and color diagrams to further ease the learning process. A discussion on clinical considerations is added to each chapter in order to guide the students to clinical application of oral biology. While preparing the second edition, I have followed the original policy “simple presentation and lucid language” which enables a self-study.

I offer this book to the dental students, hoping that this will ensure an enjoyable and rewarding study of oral biology.

Maji Jose

Acknowledgements

I thank God Almighty for all the blessings He has showered on me in this venture. The preparation of this textbook was possible only with the help and cooperation of a number of people.

I would like to express my gratitude to Dr Sripathi Rao, Principal, Yenepoya Dental College, for his kind words of encouragement and moral support, received at every stage of the preparation of this book. I also thank him for writing the Foreword to the book.

I would like to express my heartfelt thanks to Dr Heera R, faculty of Oral Pathology, Government Dental College, Thiruvananthapuram, my teacher and friend, for giving me all guidance, moral support, and for sharing her knowledge at different stages of my work, and also for contribution in the book.

I gratefully acknowledge the constant support of Dr Rajeesh Mohammed PK, Dr Girish KL, Dr Usha Balan and Dr Ajeesha Firoz who have also contributed chapters to this book. I am indebted to Head of the Department and all my colleagues of Department of Oral Pathology, Yenepoya Dental College, Mangalore, especially Dr Joshy, Dr Meera and Dr Haziel Diana Jenifer, for their constructive suggestions and timely support.

The talented staff of CBS Publishers & Distributors deserve praise for their role in shaping this book.

I owe a great deal of regard and gratitude to my parents, teachers and beloved students who have played a major role in making me what I am today. I thank my husband Mr Ajoy S. Joseph, and my children, Joe and Jiya, who stood by me at all the stages and exhibited patience and affection which enabled me to carry on with the work smoothly.

We would like to thank Mr S.K. Jain (CMD), Mr. Varun Jain (Director), Mr. YN Arjuna (Senior Vice President – Publishing and Editorial), and Mr. Ashish Dixit (Business Head – Digital Publishing, Marketing & Sales) and

his team at CBS Publishers & Distributors Pvt. Ltd. for their skill, enthusiasm, support, patience and excellent professional approach in producing and publishing this eBook.

Finally, I thank each and everyone whose contribution, direct or indirect, has made the preparation of this book a pleasant task.

Maji Jose

Syllabus

Oral Biology course includes instructions in the subject of Dental Morphology, Oral Embryology, Oral Histology and Oral Physiology.

I. TOOTH MORPHOLOGY

1. **Introduction to tooth morphology:** Human dentition, types of teeth, function, Palmer's and binomial notation systems, tooth surfaces, their junctions—line angles and point angles, definition of terms used in dental morphology, geometric concepts in tooth morphology, contact areas and embrasures—clinical significance.
2. **Morphology of permanent teeth:** Description of individual teeth, including a note on their chronology of development, differences between similar class of teeth and identification of individual teeth.
3. **Morphology of deciduous teeth:** Generalized differences between deciduous and permanent teeth. Description of individual deciduous teeth, including their chronology of development.
4. **Occlusion**

II. ORAL EMBRYOLOGY

1. **Brief review of development of face, jaws, lip, palate, and tongue,** with applied aspects.
2. **Development of teeth:** Detailed study of different stages of development of crown, root and supporting tissues of tooth and detailed study of formation of calcified tissues. Applied aspects of

disorders in development of teeth.

3. **Eruption of deciduous and permanent teeth:** Mechanisms in tooth eruption, different theories and histology of eruption, formation of dentogingival junction, role of gubernacular cord in eruption of permanent teeth.
4. **Shedding of teeth:** Mechanisms of shedding of deciduous teeth. Complications of shedding.

III. ORAL HISTOLOGY

1. **Detailed microscopic study of enamel, dentin, cementum and pulp tissue:** Age changes.
2. **Detailed microscopic study of periodontal ligament and alveolar bone:** Age changes, histological changes in periodontal ligament.
3. **Detailed microscopic study of oral mucosa:** Variation in structure in relation to functional requirements, mechanisms of keratinization clinical parts of gingiva, dentogingival and mucocutaneous junctions and lingual papillae and age changes.
4. **Salivary glands:** Detailed microscopic study of acini and ductal system.
5. **TM joint:** Review of basic anatomical aspects and microscopic study.
6. **Maxillary sinus:** Microscopic study, functions and clinical relevance of maxillary sinus in dental practice.
7. **Processing of hard and soft tissues for microscopic study:** Ground sections, decalcified sections and routine staining procedures.

IV. ORAL PHYSIOLOGY

1. **Saliva:** Composition of saliva—formation of saliva and mechanisms of secretion, functions of saliva.
2. **Mastication:** Masticatory force, need for mastication, peculiarities

of masticatory muscles, masticatory cycle, masticatory reflexes and neural control of mastication.

3. **Deglutition:** Review of the steps in deglutition, swallowing in infants, neural control of deglutition.
4. **Calcium and phosphorus metabolism:** Source, requirements, absorption, distribution, functions and excretion, clinical considerations.
5. **Theories of mineralization:** Definition, mechanisms, theories of mineralization.
6. **Physiology of taste:** Innervation of taste buds and taste pathway, physiologic basis of taste sensation, age changes.
7. **Physiology of speech**

About the Book

Essentials of
Oral Biology

Oral Anatomy, Histology, Physiology and Embroyology

is the completely rewritten, thoroughly revised, fairly enlarged and prudently updated edition of the popular book. All topics of oral biology are described in five sections: • Oral Embryology, • Oral Histology, • Oral and Dental Anatomy, • Oral Physiology and • Allied Topics.

This text provides a comprehensive coverage of all the topics included in the curriculum specified by Dental Council of India and various Indian universities.

Various topics covered in 50 different chapters, revised and updated with flowcharts, tables and colour diagrams to make learning more simple and pleasant. A discussion on clinical considerations is added to guide the students to clinical application of oral biology. An additional section on expected questions of each chapter, commonly asked in examinations of various Indian universities, will assist the students on examination preparations.

This book is based on more than two decades of experience of the author as a teacher and examiner of oral biology. This edition maintains the hallmark of the earlier edition: Lucid language and simple presentation.

About the Author

Maji Jose MDS, PhD is currently Professor and Head, Department of Oral Pathology, Yenepoya Dental College and Hospital, Yenepoya University, Deralakatte, Mangalore, Karnataka. She has more than two decades of experience in teaching oral biology and oral pathology to undergraduate and postgraduate students in various distinguished dental colleges such as Manipal College of Dental Sciences, KVG Dental College, Sullia, and Yenepoya Dental College. She has been examiner for both undergraduate and postgraduate students at various universities.

Dr Jose, well acknowledged as a teacher, examiner and researcher, obtained PhD in 2013 from Yenepoya University and has to her credit over 50 scientific publications in Indian and international journals of repute. Her other textbook *Manual of Oral Histology and Oral Pathology* (CBS) is well accepted and widely used by dental students and teachers of many Indian and foreign universities.

Contents

Section 3: Oral and Dental Anatomy

Section 4: Oral Physiology

Section 5: Allied Topics

Section 1

Oral Embryology

1. **General Embryology**
2. **Development of Orofacial Structures**

1 General Embryology

Formation of blastocyst

Germ layers

Neural crest cells

Pharyngeal arches and pouches

Embryology is the study of growth and differentiation which an organism undergo during its development from a single fertilized cell to a complex independent living being.

Every animal starts life in the form of a simple cell, i.e. the fertilized egg or zygote. Zygote is formed by two cells, namely the germ cells of parents. Fertilization occurs when male and female gamates (spermatozoon and ovum) unite to form zygote.

The intrauterine life of human beings can be devided into embryonic period which lasts for 8 weeks after fertilization which will be followed by fetal period which continues throughout pregnancy that ends in birth approximately after 280 days.

After fertilization, rapid proliferation of cells takes place leading to formation of a cell mass called morula. This morula is a “golf ball” like a little mass of cells and consists of a group of centrally placed cells termed as inner cell mass, surrounded by a peripheral layer of cells (Fig. 1.1). Once morula enters into the uterine cavity by 7 to 8 days, it turns into a fluid filled structure due to seepage of fluid, which separates the inner cell mass from peripheral layer of cells. The resultant structure is called blastocyst (Fig. 1.2).

This blastocyst is lined by a layer of cells called trophoblasts. The trophoblasts are derived from the outer layer of morula, which later gives rise

to placenta and is also involved in implantation of the embryo. Within the blastocyst, the inner cell mass can be seen attached to one side of the inner aspect. This inner cell mass or embryoblasts forms the embryonic stem cells that gives rise to embryo.

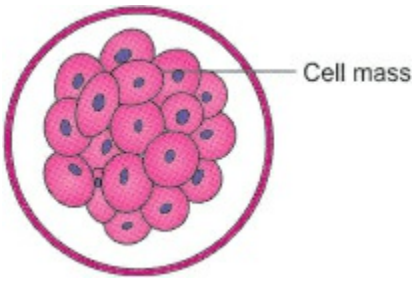

Fig. 1.1: Morula

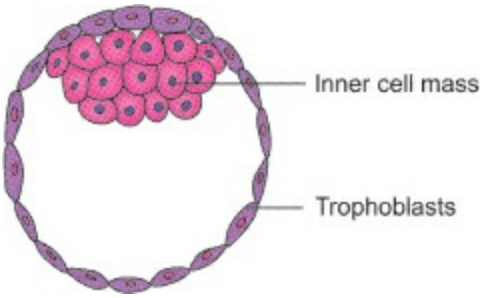

Fig. 1.2: Blastocyst

At this stage, the blastocyst has two different types of cells. The inner cell mass that occupies the center portion and an outer layer that surrounds this cell mass. As the blastocyst develops further, some cells of the inner cell mass differentiate into flattened cells and line the free surface while the other cells change into columnar cells. The flattened cells constitute the endoderm while the columnar cells forms the ectoderm. Thus, by 8th day of gestation the embryo appears like a ‘bilaminar circular disc’.

As the development proceeds, in a localized area close to the future cephalic end of the disc, flattened cells of endoderm changes into columnar cells. This circular area where the changes takes place is called ‘prochordal plate’. The region where the prochordal plate is formed is the head end and opposing end is tail end of the embryo. Prochordal plate provides the disc an antero-posterior axis and a bilateral symmetry.

After the formation of the prochordal plate, the cells of ectoderm proliferate near the tail end, forming another structure called the primitive streak. These proliferating cells initially form a thickening and later spread

sideways between ectoderm and endoderm forming a third layer called mesoderm. This mesodermal layer spreads and separates the ectoderm and endoderm throughout the disc except for the circular region of prochordal plate. So by the 16th day, the embryonic disc has three layers: Ectoderm, endoderm and mesoderm. These three primary germ layers give rise to different tissues and organs of our body.

Germ Layer Derivatives

Structures of Ectodermal Origin are

Cutaneous structures

- Skin and its appendages
- Oral mucous membrane
- Enamel of teeth

Neural system-central and peripheral nerve systems

Structures of Mesodermal Origin are

Cardiovascular system—heart and blood vessels

Locomotor system—bones and muscles

Connective tissue

Components of teeth other than enamel

Structures of Endodermal Origin are

Lining epithelium of respiratory tract

Lining epithelium of alimentary tract

Secretory cells of liver and pancreas

As the development progresses, the circular disc shaped embryo becomes elongated and pear shaped. The region of prochordal plate where ectoderm and endoderm remain in contact forms the ‘buccopharyngeal membrane’.

The cranial end of the primitive streak thickens to form primitive node. The cells proliferate from primitive node and extend between the ectoderm and endoderm, along the central axis up till the prochordal plate. This forms

notochordal process or head process. Ectoderm over the notochord differentiates to form neural plate which develops an invagination and forms the neural tube. This neural tube extends from primitive node to prochordal plate. The cranial part of neural tube forms the brain and caudal part forms the spinal cord.

The enlarging embryonic disc develops folds at its head end (cranial fold), tail end (caudal fold) and laterally, making the embryo entirely covered by ectoderm.

Neural Crest Cells

Neural crest cells are a group of pleuripotent cells that develop from ectoderm along the lateral margins of neural plate. These cells migrate extensively in the developing embryo between ectoderm and endoderm and intra-mesodermally and differentiate into different types of cells that forms various tissues of the body.

The neural crest cells move around the sides of the developing head beneath the surface of ectoderm as sheets of cells. They migrate and form the entire connective tissue of upper facial region; while in the lower facial region they migrate into already existing mesenchyme. Therefore the connective tissue beneath the developing ectoderm in this region is called ectomesenchyme.

Derivatives of the branchial arches, pharyngeal pouches and cranial somites

Branchial arch	*Branchial pouch*	*Arch arteries*	*Muscles*	*Nerves*	*Skeleton*
1st: **Mandibular** Contributes to facial prominences and anterior tongue mucosa	(D) Tubotympanic recess, which forms auditory tube and middle ear cavity (V) Obliterated by tongue	Contributes to external carotid and maxillary arteries	Muscles of mastication (temporal masseter, and pterygoids), mylohyoid, ant. digastric, tensor veli palatini, tensor tympani (originates from somitomere 4)	Vth nerve; Trigeminal nerve, three divisions: Sensory, mandibular, motor	Facial bones, incus, malleus, anterior ligament of melleus, sphenomandibular ligament and core of mandible from Meckel's cartilage
2nd: **Hyoid** Contributes to anterior tongue mucosa	(D) Mostly filled in by own proliferation to form palatine tonsillar fossa (V) Obliterated by tongue	Stapedial artery (in part), possibly small contribution of facial artery	Muscles of facial expression, posterior digastric, stylohyoid, stapedius (originates from somitomere 6)	VIIth nerve: Facial nerve, motor to facial muscles, sensory to ant. 2/3rds of the tongue	Stapes styloid process, stylohyoid ligament, lesser horn and upper part of hyoid body (Reichert's cartilage)
3rd Contributes to posterior tongue mucosa	(D) Inferior parathyroid III (V) Thymus	Proximal 1/3rd of internal carotid, possibly small contribution to common carotid	Stylopharyngeus, upper pharyngeal muscles (originates from somitomere 7)	IXth nerve: Glossopharyngeal nerve (pharyngeal plexus), motor to pharynx	Greater horn and lower part of hyoid body
4th	(D) Superior parathyroid IV (V) Lateral thyroid Vestigial thymus	Arch of aorta (left), proximal part of right subclavian (right)	Pharyngeal constrictors, cricothyroid and laryngeal muscles Palatoglossus Palatopharyngeus Levator veli palatini	Sensory to post 1/3rd of tongue	Thyroid and laryngeal cartilages
5th	Ultimobranchial body or calcitonin C cells	Rarely seen	Same as 4th branchial arch	Xth nerve: Vagus nerve, superior laryngeal nerve (pharyngeal nerve plexus)	Lower part of thyroid cartilage and laryngeal cartilages
6th	None	Proximal part of both pulmonary arteries and most of ductus arteriosus (left)	Laryngeal muscles except cricothyroid striated muscles of esophagus (originates from occipital somites 1 and 2)	Xth nerve: Vagus nerve, inferior laryngeal nerve	Cricoid cartilage (probably) and arytenoid cartilages
Post-branchial region, somites, somitomeres, 4 occipital somites			Trapezius, sternomastoid Myotonic Muscle, intrinsic tongue muscles, styloglossus, hyoglossus tongue, genioglossus muscles extrinsic ocular muscles	XIth: Spinal accessory XIIth nerve: Hypoglossal nerve, IIIrd: Oculomotor, IVth: Trochlear, VIth: Abducens	Tracheal cartilages? sclerotomes basioccipital bone, nasal capsule? Nasal septum?
Upper cervical somites			Geniohyoid, infrahyoid muscles	Spinal nerves C1, 2	Cervical vertebrae

The Structures that Develop from the Neural Crest Cells

In the head and neck region neural crest cells differentiate to form most of the connective tissue components including bone, cartilage, dermis and tissues that form tooth except enamel and also contributes to formation of muscles and arteries of this region.

Neural crest cells migrate to the trunk region giving rise to neural, endocrine and pigment producing cells. In the trunk sensory ganglions, Schwann cells and neurons are also derived from neural crest cells.

Neural crest cells have a significant role in craniofacial development and formation of teeth. A developmental disorder called ***Treacher Collin syndrome*** which manifest with various craniofacial developmental defects is caused due to defective migration of neural crest cells. Defective migration of neural crest cells can also cause defective dentition.

Branchial Arches and Pouches

The developing oral cavity, stomatodeum is situated between the developing brain and pericardium. In the early stages, neck is not present. Later, series of mesodermal thickenings develop in the wall of the cranial part of foregut resulting in the formation of neck between stomodeum and pericardium. These cylindrical thickenings are called branchial arches or pharyngeal arches (Fig. 1.3).

Pharyngeal arches are six in number and extend from lateral wall of pharynx, towards the medial direction, to approach its counterpart extending from other side. The inner aspect of each arch is covered by endoderm and outer aspect by ectoderm. The central core is made up of mesenchyme, which is surrounded by ectomesenchyme, which is of neural crest origin. The endoderm extends outwards between the branchial arches in the form of pouches called ***pharyngeal pouches.*** The pharyngeal pouches meet the ectodermal clefts which are formed by invagination of ectoderm lining the outer surface of the pharyngeal arches.

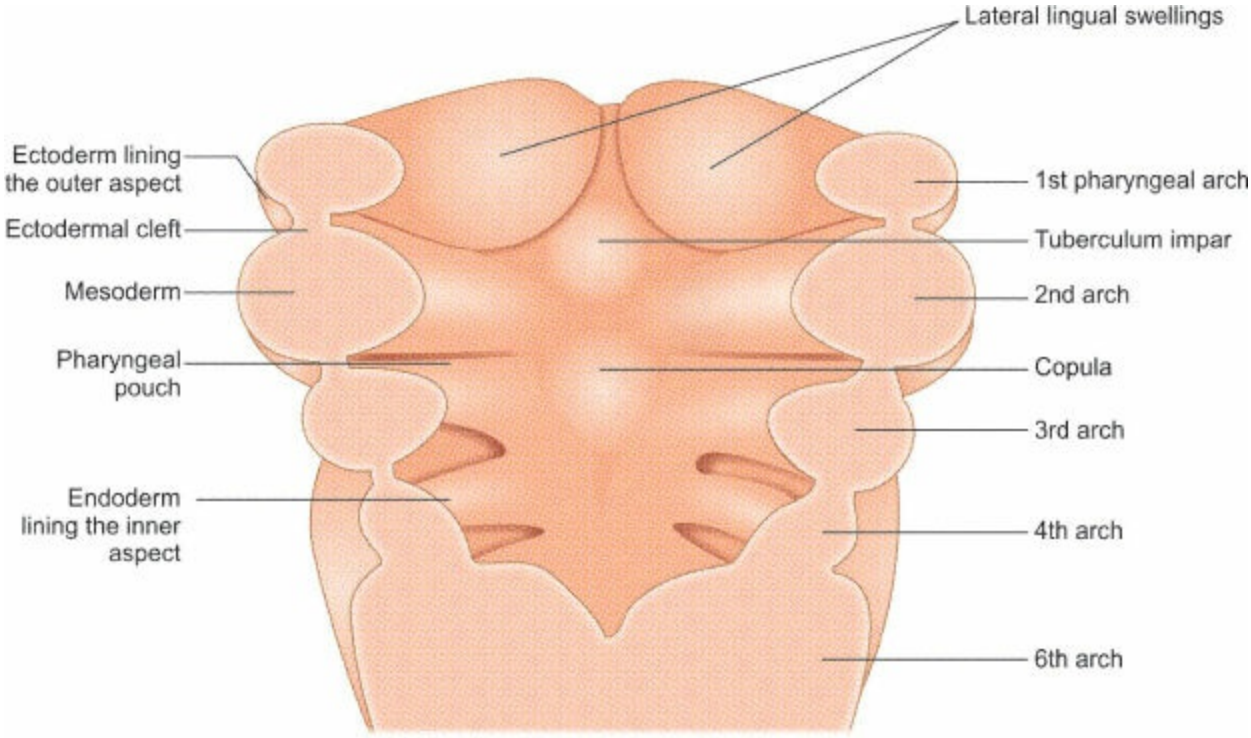

Fig. 1.3: Pharyngeal arches and pouches

The mesoderm of each arch gives rise to a skeletal element (which can be either a cartilage or bone), muscle and an arterial arch. Each pharyngeal arch has a nerve which supplies the structures that develop from that arch.

There are six pharyngeal arches. 1st arch is named as mandibular arch, which plays a very important role in craniofacial development.

2nd arch is hyoid arch and the 5th arch disappears soon after formation. The remaining 3, 4, 6 arches do not have specific names.

2

Development of Orofacial Structures

Formation of orofacial structure

Orofacial structures develop primarily from first, second and third branchial arches by fusion of various processes.

Formation of Face

Brain and pericardium forms two prominent bulgings on the ventral aspect of the embryo after the head fold is formed. These two prominences are separated by a central depression called stomatodeum which is the developing oral cavity and is formed by an invagination of ectoderm on the ventral surface of future head of the embryo. In the deepest part of the stomatodeum, the lining ectoderm is in contact with endoderm of the foregut. This combined ectoderm and endoderm constitute the buccopharyrngeal membrane which separates the developing oral cavity from foregut. The mesoderm of the forebrain proliferates and forms a bulge that overlaps the upper part of stomatodeum. This downward bulge is called frontonasal process. Face develops from the frontonasal process and the 1st pharyngeal (mandibular) arch of each side.

The ectoderm lining the frontal process forms thickenings on both infero-lateral borders. These are called nasal or olfactory placodes. These nasal placodes invaginate to form nasal pit. This nasal pit is surrounded by a horseshoe shaped ridge which is formed by rapid proliferation of underlying mesoderm. The medial edge of this ridge is called medial nasal process and lateral edge is called lateral nasal process and the depressed area between the two medial nasal processes is called frontonasal process.

At the same time the mandibular arches that form the lateral wall of stomatodeum gives off a bud-like projection called maxillary process (on either side). The remaining part of the mandibular arch forms the mandibular process.

The face is derived from the five prominences that surround the stomatodeum. These prominences are frontonasal process, pair of maxillary processes and a pair of mandibular processes (Fig. 2.1).

Lower Lip

Lower lip develops from the mandibular processes which grow medially towards each other and fuses at midline. This forms the lower margin of stomatodeum. As the development continues an ectodermal proliferation occurs which extends into the ectomesenchyme. The structure developed is called vestibular lamina and it gives rise to a V-shaped sulcus that separates the lip from the tooth bearing area.

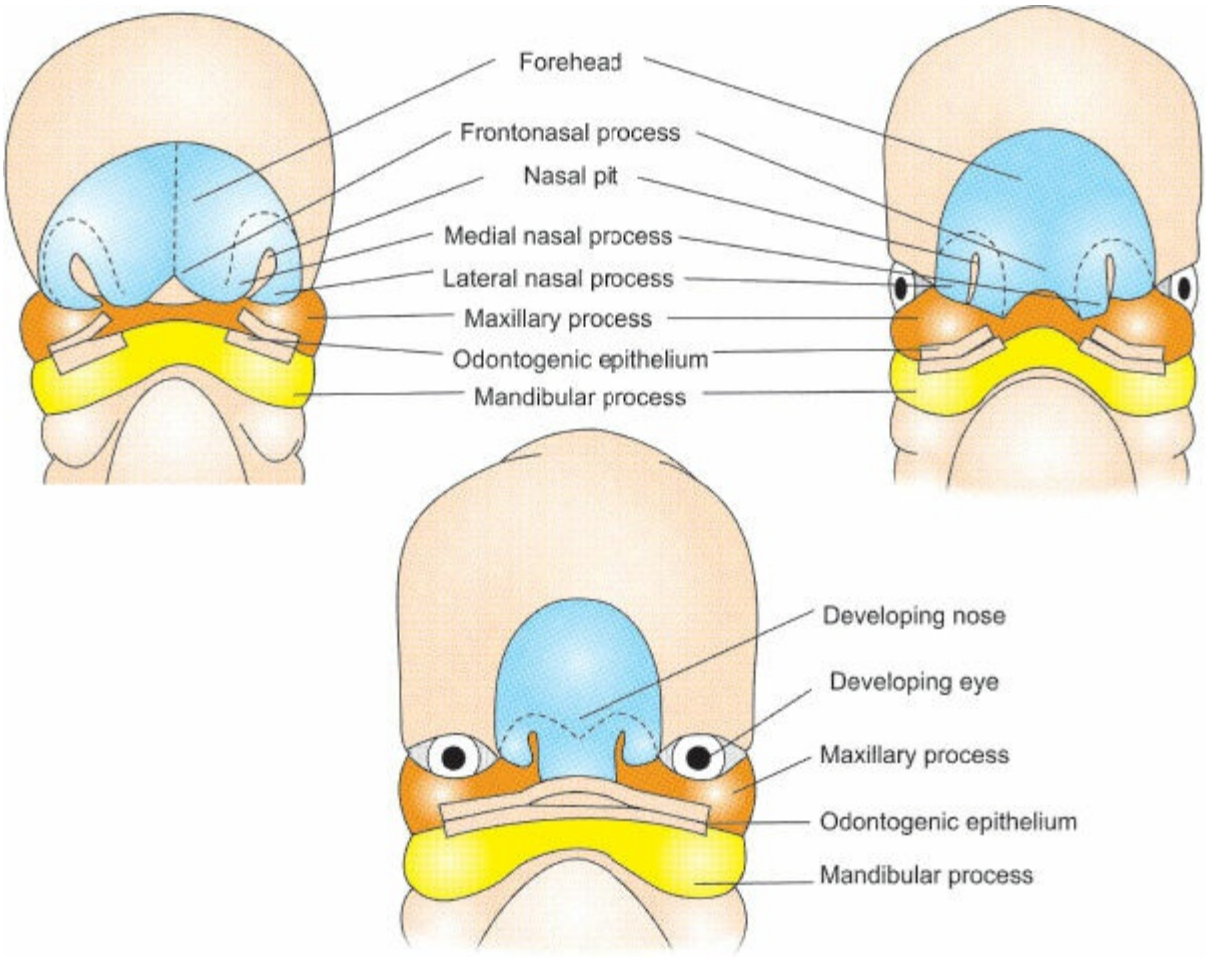

Fig. 2.1: Development of face

Upper Lip

Mandibular arch on either side gives rise to process called maxillary processes. These processes grow forward and medially towards one another above the stomatodeum. As they do so, these processes first fuse with lateral nasal process and later with medial nasal process. The frontonasal process grows downwards at a faster rate and reaches the same level that of maxillary process. The inferolateral part of the frontonasal process is now called as globular process. As the maxillary process grows, the frontonasal process becomes narrower and the external nares formed by the fusion of medial and lateral processes come closer. Both maxillary processes form the major part of lip except for philtrum region. In this region mesoderm is derived from frontonasal process. The ectoderm of the maxillary process overgrows this mesoderm to meet that of the opposite side. The upper lip is separated from the developing jaw in the same manner as that of lower lip.

Cheek

After formation of upper and lower lip the lateral margins of maxillary and mandibular processes fuses with each other to form cheek.

FORMATION OF PALATE

During the medial growth of maxillary processes, they not only form the upper lip but also extend backward on either side of stomatodeum. From this backward extension of maxillary process, two plates like shelves grow medially. These are called palatal processes (Fig. 2.2). Meanwhile the primary palate is formed from the frontonasal process. Initially these three structures are widely separated because of the vertical orientation of palatal processes (lateral shelves) on either side of the tongue. During 8th week of intrauterine development after the descent of tongue, the palatine shelves alter their position from vertical to horizontal direction as a preparation to their fusion. Two palatal shelves, which grows medially towards each other and fuse in the midline and with the posterior margin of the primary palate to form a flat and unarched roof of the mouth, separating nasal cavity from oral

cavity. Palatal shelves also fuse with nasal septum to separate two nasal cavities. The fusing palatal shelves overlap the primary anterior palate and the junction of union of these three palatal components is marked by incisive papilla overlying the incisive canal.

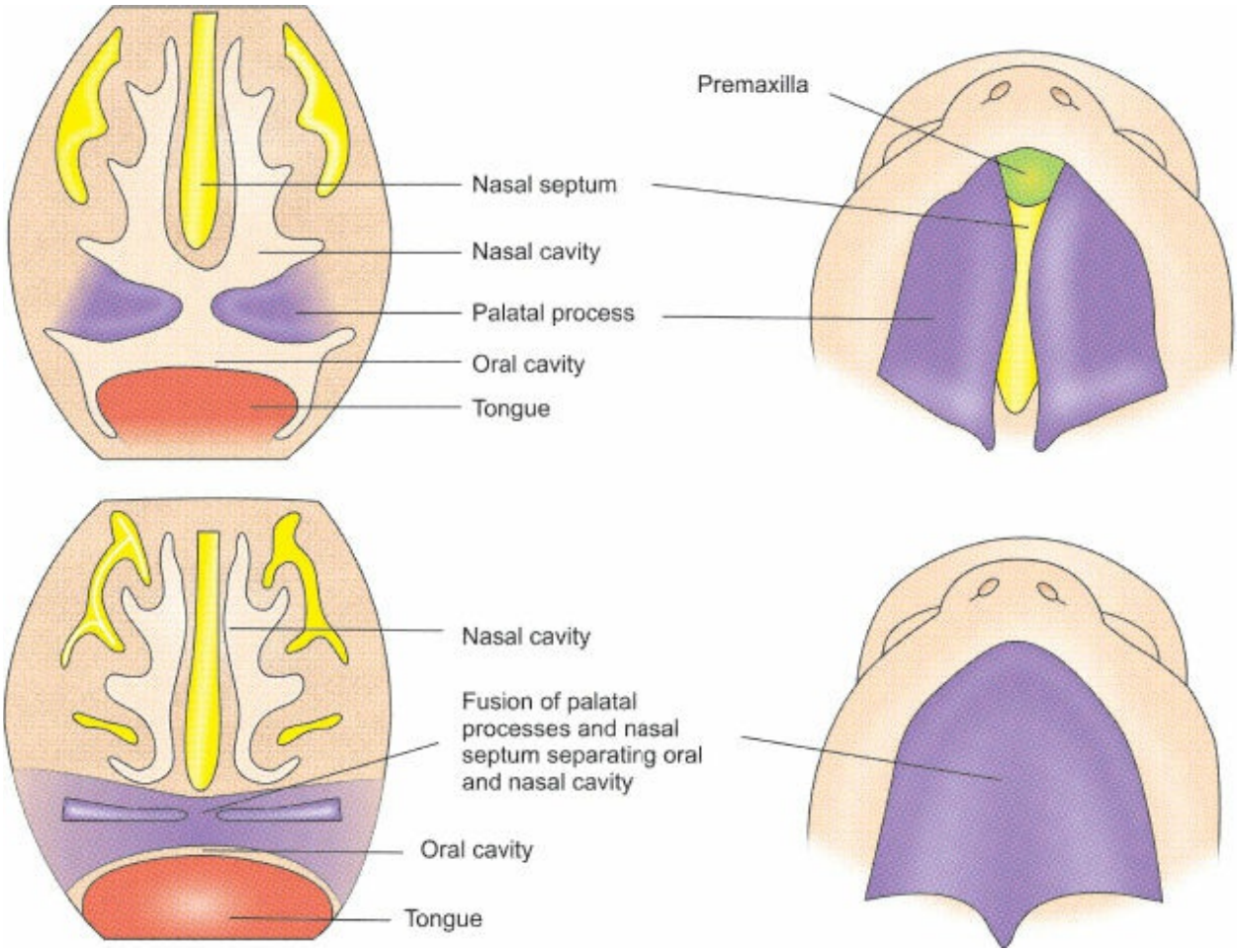

Fig. 2.2: Development of palate

Ossification of palate starts at the 8th week of intrauterine life by intramembranous ossification of mesoderm. The hard palate grows in length, breadth and height and changes into an arch shaped roof for the mouth. The apposition growth of the alveolar process also contributes to deepening as well as widening of the vault of palate.

Ossification does not occur in the most posterior part of the palate giving rise to the region of soft palate. Myogenic mesenchyme from the 1st, 2nd and 4th arches migrate to this region giving rise to musculature of soft palate.

Development of Tongue

The tongue develops in the ventral wall of the primitive oropharynx from the inner lining of 1st, 2nd, 3rd and 4th pharyngeal arches (Fig. 2.3). The mucous membrane lining the oropharynx rises into the developing oral cavity as swellings as a result of invasion by muscle tissue from occipital somites.

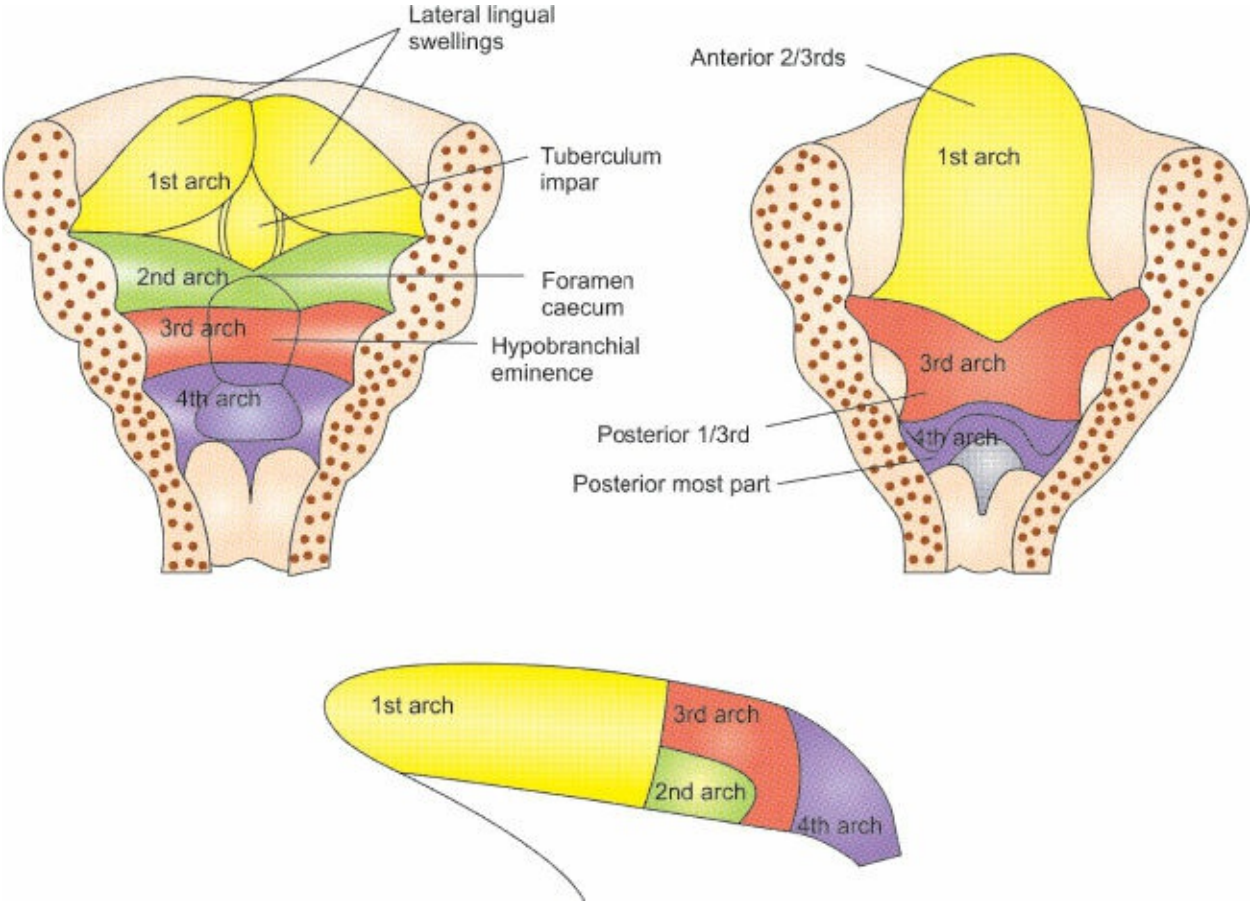

Fig. 2.3: Development of tongue

During 4th week of intrauterine life, from the internal aspect of both mandibular arches (1st branchial) mesenchymal thickenings develop which are called lateral lingual swellings. Between and behind these lateral swellings a median swelling named tuberculum impar appears. Immediately behind tuberculum impar the epithelium proliferates to form a down growth from which the thyroid develops. This structure is called thyroid diverticulum or thyroglossal duct. The region where the thyroglossal duct originates is marked by a depression called foramen caecum.

Lateral Lingual Swellings

Anterior 2/3rds of the tongue is formed from the mandibular arch by the

fusion of two lateral lingual swellings and tuberculum impar. As the lingual swellings grow and fuse with each other, they over grow the tuberculum impar and therefore the ectodermal lining of entire anterior 2/3rds is derived from these two swellings and is of ectodermal origin. After these structures fuses the epithelium at the periphery proliferates into the mesenchyme to form a horseshoe shaped lamina all around. The central cells of this lamina degenerate to form linguo-gingival groove which separate the body of the tongue from floor of the mouth except for the region of frenum of tongue.

The posterior 1/3rd of the tongue develops from another swelling known as hypobranchial eminence. This hypobranchial eminence is derived from 2nd, 3rd and 4th arches. The epithelial lining of posterior 1/3rd is endodermal in origin. As the development progresses the mesoderm of the 3rd branchial arch overgrow the mesoderm of 2nd arch and joins with mesoderm of 1st arch. The second arch mesoderm remains buried below the surface (Fig. 2.3). A V-shaped ‘sulcus terminalis’ demarcate the anterior 2/3rds and posterior 1/3rd of tongue. The posterior most part of the tongue is derived from the 4th arch.

The epithelium of the tongue is derived partly from both ectoderm and endoderm and is single layered initially which later turns to stratified squamous epithelium. Circumvallate papillae develop by 2nd to 5th months of intrauterine life. Fungiform papillae develop at an earlier stage by 11th week of intrauterine life while filiform papillae develop later and development is completed only postnatally. The taste buds develop by the inductive interaction between epithelial cells and invading gustatory nerve cells from chorda tympani, glossopharyngeal and vagus nerves. The mucosa lining the posterior part of the tongue becomes pitted by deep crypts that develop into lingual tonsil.

The muscles of the tongue have a dual origin. The intrinsic muscles probably arise *in situ* in the pharyngeal arch mesenchyme while the extrinsic muscles arise in the occipital somite region opposite to origin of hypoglossal nerve. The muscle mass migrates forward beneath the mucosal layers of the tongue which also carries the hypoglossal nerve.

In the initial stages of development, tongue enlarges rapidly and occupies the whole of stomatodeum. Later as the stomatodeum increases in size the tongue descends down allowing the palatal shelves to become horizontal. The entire tongue is in the mouth at birth and by the 4th year posterior 1/3rd descends down to pharynx. The size of the tongue doubles in length, width