

1 **ANAT2300 - Vertebrate Development A** **Lecture 9**

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3 **Lecture Overview**

- Head and Neck
- Skull
- Early Pharynx and Face
- Pharyngeal Arches
 - components
 - structures formed
- Pharynx
- Brief coverage
 - External ear
 - Tongue
 - Teeth
- Abnormalities

4 **External Head/Face**

5 **Early Face and Pharynx**

- Pharynx
 - buccopharyngeal membrane
 - oral membrane
 - apposition of ectoderm with endoderm
 - no mesoderm between
- Head/Skull
 - chondrocranium forms base of skull
 - in lower vertebrates encases brain
 - cranial vault
 - calveria
 - facial skeleton
 - pharyngeal arches
- Sensory Placodes

6 **Head Growth**

- continues postnatally
 - fontanelle allow head distortion on birth and early growth
- bone plates remain unfused to allow growth
- puberty growth of face

7 **Skull Overview**

- Chondrocranium
 - formed from paraxial mesoderm
 - cranial end of vertebral column
 - modified vertebral elements
 - occipital and cervical sclerotome

- bone preformed in cartilage
 - endochondrial ossification
- Cranial Vault and Facial Skeleton
 - formed from neural crest
 - muscle
 - paraxial mesoderm
 - somitomeres and occipital somites

8 Skull- species comparison

9 Calveria

- bone has no cartilage
 - direct ossification of mesenchyme
 - intramembranous ossification
- bones do not fuse
- fibrous sutures
 - allow distortion to pass through birth canal
 - allow growth of the brain
 - 6 fontanelles
 - posterior closes at 3 months
 - anterior closes at 18 months

10 Calveria

11 Face

- derived from pharyngeal or branchial arches
- Humans have 5 arches
 - **1, 2, 3, 4, 6**
 - Arch **5** does not form or regresses
- from in rostro-caudal sequence
 - Arch **1** -> **6** from week 4 onwards
 - **1** and **2** appear at time of closure of cranial neuropore
- each arch has initially similar components
 - but forms different structures
- Face mainly arch **1** and **2**
- Neck components arch **3** and **4**
 - arch **4** and **6** fuse

12 Stage 13/14 Pharyngeal Arches

13 Arch Layers and Components

14 Arch Layers and Components

- branchial arch
 - Gk. branchia= gill, is a misnomer
- consists of all 3 trilaminar embryo layers
 - ectoderm- outside
 - mesoderm- core of mesenchyme
 - endoderm- inside

15 Neural Crest

- Arch mesenchyme invaded by neural crest
- generating connective tissue components
 - cartilage, bone, ligaments
- arises from midbrain and hindbrain region

16 Arch Features

- Each arch contains
 - artery
 - cartilage
 - nerve
 - muscular component
- Arches and Pharynx Form
 - face, tongue, lips, jaws, palate, pharynx, neck
 - cranial nerves
 - sense organ components
 - glands

17 Arch Features

- arch
- groove
 - externally separates each arch
 - also called a cleft
 - only first pair persist as external auditory meatus
- pouch
 - internally separates each arch
 - pockets from the pharynx
- membrane
 - ectoderm and endoderm contact regions
 - only first pair persist as tympanic membrane

18 Pharyngeal Arches

- Arch 1 Mandibular Arch
 - has 2 prominences
 - Maxillary
 - smaller upper
 - forms maxilla, zygomatic bone and squamous part of temporal
 - Mandibular
 - larger lower
 - Forms mandible
- Arch 2 Hyoid Arch
 - forms most of hyoid bone
- Arch 3 and 4
 - neck structures

19 Arch Arteries

- Arch 1
 - mainly lost, form part of maxillary artery
- Arch 2
 - stapedial arteries
- Arch 3
 - common carotid arteries, internal carotid arteries

- Arch 4
 - left forms part of aortic arch
 - right forms part right subclavian artery
- Arch 6
 - left- forms part of left pulmonary artery
 - right- forms part of right pulmonary artery

20 Arch Artery Derivatives

21 Arch Cartilage

- Arch 1- Meckel's cartilage
 - dorsal ends form malleus and incus
 - midpart forms ligaments
 - ant. malleus, sphenomandibular
 - ventral part forms mandible template
 - horseshoe shaped
- Arch 2- Reichert's cartilage
 - dorsal ends form stapes and Temporal bone styloid process
 - ventral part ossifies to form hyoid bone components
 - lesser cornu and superior body
- Arch 3- Hyoid components
 - greater cornu and inferior part of hyoid
- Arch 4&6- Laryngeal cartilages
 - except epiglottis (from hypobranchial eminence)

22 Arch Cartilage

23 Arch Muscle

- Arch 1
 - muscles of mastication, mylohyoid, tensor tympanic, anterior belly digastric
- Arch 2
 - muscles of facial expression, stapedius, stylohyoid, posterior belly digastric
- Arch 3
 - stylopharyngeus
- Arch 4&6
 - crycothyroid, pharynx constrictors, larynx muscles,
 - oesophagus (st. muscle)

24 Arch Muscles

25 Arch Nerve

- Arch 1
 - CN V trigeminal
 - caudal 2/3 maxillary and mandibular
 - cranial 1/3 sensory nerve
 - head and neck, mastication motor
- Arch 2
 - CN VII facial
- Arch 3
 - CN IX glossopharyngeal
- Arch 4&6
 - CN X vagus
 - arch 4- superior laryngeal
 - arch 6- recurrent laryngeal

26 Arch Nerves

27 Arch Pouches

- Arch 1
 - elongates to form tubotympanic recess
 - tympanic cavity, mastoid antrum, Eustachian tube
- Arch 2
 - forms tonsillar sinus
 - mostly obliterated by palatine tonsil
- Arch 3
 - forms inferior parathyroid and thymus
- Arch 4
 - forms superior parathyroid, parafollicular cells of Thyroid

28 Arch Pouches

29 Thyroid Gland

- not a pouch structure
- first endocrine organ to develop day 24
- from floor of pharynx
 - descends thyroglossal duct (which closes)
 - upper end at foramen cecum

30 Thyroid Development

31 Face Development

- begins week 4 centred around stomodeum
 - external depression at oral membrane
- 5 initial primordia
 - from neural crest mesenchyme
- 1 frontonasal prominence (FNP)
 - forms forehead, nose dorsum and apex
 - nasal placodes develop later bilaterally
 - pushed medially
- 2 maxillary prominences
 - form upper cheek and upper lip
- 2 mandibular prominences
 - lower cheek, chin and lower lip

32 Face Development (week 4-5)

33 Face Development (week 6-10)

34 Sensory Placodes

- Sensory Development
 - Covered in another Lecture
- Surface Components
 - Otic placode
 - Optic placode
 - Nasal placode

35 Ear

- **Ear Auricles (pinna)**
 - form from 6 hillocks (week 5)
 - 3 on each of arch 1 and 2
- **Otocyst**
 - sensory placode that forms earlier and sink from surface
 - forms inner ear structures

36 External Ear

37 Tongue Development

- from all arches
 - which changes with time
- begins as swelling rostral to foramen caecum
 - median tongue bud
- Arch 1 - oral part of tongue (ant 3/2)
- Arch 2 - initial contribution to surface is lost
- Arch 3 - pharyngeal part of tongue (post 1/3)
- Arch 4 - epiglottis and adjacent regions
- Salivary Glands
 - epithelial buds in oral cavity (wk 6-7) extend into mesenchyme
 - parotid, submandibular, sublingual

38 Tongue Development

39 Abnormalities

- Congenital
 - Syndromes
 - First Arch, Pierre Robin, DiGeorge, Treacher Collins
 - Glands
 - Accessory thymic tissue, Ectopic parathyroid glands, Thyroid
 - Branchial
 - Sinuses, Fistula, Cysts, Vestiges
 - Cleft
 - Palate, Lip
- Maternal
 - Retinoic acid
 - alcohol

40 Abnormalities

- Cleft Lip and Palate
 - 300+ different abnormalities
 - different cleft forms and extent
 - upper lip and ant. maxilla
 - hard and soft palate
- Australian national rate (1982-1992)
 - Cleft Palate
 - 4.8 - 6 /10,000 births
 - Cleft Lip
 - 8.1 - 9.9 /10,000 births

41 Abnormalities

- First Arch Syndrome

- 2 major types, both result in extensive facial abnormalities
- Treacher Collins Syndrome
- Pierre Robin Syndrome
 - Hypoplasia of the mandible, cleft palate, eye and ear defects
 - Initial defect is small mandible (micrognathia) resulting in posterior displacement of tongue and a bilateral cleft palate
- DiGeorge Syndrome
- absence of thymus and parathyroid glands
- 3rd and 4th pouch do not form
- disturbance of cervical neural crest migration
- Cysts
 - many different types

42 Abnormalities - Maternal Effects

- Retinoic Acid
 - present in skin ointments
 - In 1988 associated with facial developmental abnormalities

43 Abnormalities - Maternal Effects

- Fetal Alcohol Syndrome
 - alcohol in early development (week 3+)
 - facial and neurological abnormalities
 - lowered ears, small face, mild+ retardation
 - embryos in vitro exposed to ethanol simulates premature differentiation of prechondrogenic mesenchyme of the facial primordia (1999)

44 Molecular Mechanisms

- Human Embryos
 - gene expression in head region follows that seen in other species embryo models
 - Branchial HOX Gene Expression and Human Craniofacial Development Vieille-Grosjean et al. Dev Biol. 1997