Parasympathetic Ganglia, Arteries, Pharyngeal Arches and Clinical Terms

Introduction

This section deals with the major autonomic and neural structures of the head and neck. It includes the parasympathetic ganglia, important arteries, pharyngeal arch derivatives, and clinically relevant anatomical terms. Understanding these nerves and ganglia is essential for correlating cranial nerve functions with glands, smooth muscles, and mucosal secretions.

Cervical Plexus

- Formed by the **anterior rami of C1–C4**.
- Lies deep to the sternocleidomastoid on the levator scapulae and scalenus medius.
- Divided into **cutaneous** and **muscular branches**.

Cutaneous branches (nerve point of neck)

- Lesser occipital nerve
- Great auricular nerve
- Transverse cervical nerve
- Supraclavicular nerves

These emerge from the **midpoint of the posterior border of sternocleidomastoid**.

Muscular branches

- Supply prevertebral muscles, levator scapulae, trapezius (with accessory nerve).
- Contributes fibres to the **ansa cervicalis** for infrahyoid muscles.

Phrenic Nerve

- Arises from **C3, C4, C5** (“C3,4,5 keep the diaphragm alive”).
- Descends on the anterior scalene muscle.

• Enters thorax between subclavian artery and vein.
• **Motor nerve of the diaphragm**.
• Sensory to:
– Mediastinal pleura
– Central diaphragmatic pleura
– Central diaphragm peritoneum

Clinical relevance

• Irritation of phrenic nerve ? **referred pain to shoulder** (C4 dermatome).
• Phrenic nerve palsy ? **elevated hemidiaphragm** on X-ray.

Sympathetic Trunk (Cervical Part)

• Lies behind the carotid sheath, anterior to prevertebral fascia.
• Contains **no white rami communicantes** (these appear only T1–L2).
• Consists of three ganglia:

Superior Cervical Ganglion

• Largest; located at C2–C3 level.
• Sends fibres to head and neck: pupil dilation, sweating, vasoconstriction.

Middle Cervical Ganglion

• Small; at C6 level, near cricoid cartilage.

Inferior Cervical Ganglion

• Often fuses with first thoracic ganglion ? **stellate ganglion**.

Clinical relevance

• Interruption produces **Horner syndrome** (ptosis, miosis, anhidrosis).

Parasympathetic Ganglia (Overview)

Four paired parasympathetic ganglia supply structures of the head:

- **Ciliary ganglion**
- **Pterygopalatine ganglion**
- **Submandibular ganglion**
- **Otic ganglion**

All receive:

- Parasympathetic root (secretomotor)
- Sympathetic root
- Sensory root
- **Only parasympathetic fibres synapse** inside the ganglion.

Submandibular Ganglion

- Small, fusiform ganglion suspended from the **lingual nerve**.
- Located on the medial surface of the submandibular gland.

Roots

- **Parasympathetic root:**
  – From chorda tympani ? joins lingual nerve ? reaches the ganglion ? synapses.

- **Sympathetic root:**
  – From facial artery plexus; fibres pass through without synapse.

- **Sensory root:**
  – From lingual nerve.

Distribution

- **Postganglionic parasympathetic fibres** supply:
  – **Submandibular gland** (secretomotor)
  – **Sublingual gland**
  – Small mucous glands in floor of mouth

Clinical relevance

• Lesions ? dryness of mouth, reduced submandibular–sublingual secretion.
• Important in surgeries involving floor of mouth, submandibular duct, and lingual nerve.

Pterygopalatine Ganglion

• Largest parasympathetic ganglion in the head.
• Lies in the **pterygopalatine fossa**, just below the maxillary nerve.

Roots

• **Parasympathetic root:**
– Preganglionic fibres via **greater petrosal nerve**.
– Joins deep petrosal nerve ? **nerve of pterygoid canal** ? ganglion ? synapse.

• **Sympathetic root:**
– From **deep petrosal nerve** (plexus around internal carotid).
– Pass through without synapse.

• **Sensory root:**
– From **maxillary nerve (V2)**.

Distribution

• Lacrimal gland (via lacrimal nerve pathway).
• Nasal mucous glands.
• Palatine mucous glands.
• Nasopharyngeal glands.

Clinical relevance

• Ganglion block used in migraine and cluster headache.
• Lesions ? dryness of nasal and palatal mucosa, reduced tear secretion.

Otic Ganglion

• Small parasympathetic ganglion located **below the foramen ovale**, medial to mandibular nerve.

• Functionally associated with **glossopharyngeal nerve (IX)**.

Roots

• **Parasympathetic root:**
– Preganglionic fibres via **lesser petrosal nerve** ? synapse in ganglion.

• **Sympathetic root:**
– From plexus around **middle meningeal artery**; pass through.

• **Sensory root:**
– From mandibular nerve (V3).

Distribution

• Secretomotor supply to **parotid gland**, via **auriculotemporal nerve**.

Clinical relevance

• Lesions lead to reduced parotid secretion.
• Site of Frey syndrome (gustatory sweating) when auriculotemporal nerve regenerates aberrantly.

Ciliary Ganglion

• Small parasympathetic ganglion located in the **orbit**, between optic nerve and lateral rectus.

Roots

• **Parasympathetic root:**
– From **oculomotor nerve** (branch to inferior oblique).
– Synapse inside ganglion.

• **Sympathetic root:**
– From **internal carotid sympathetic plexus**; pass through.

• **Sensory root:**
– From **nasociliary nerve**.

Distribution

• Postganglionic fibres emerge as **short ciliary nerves** supplying:
– Sphincter pupillae (pupil constriction)
– Ciliaris muscle (accommodation)

Clinical relevance

• Lesions cause:
– Dilated pupil (loss of sphincter pupillae)
– Loss of accommodation
– Light-near dissociation in selective damage

Arteries of Head and Neck

Common Carotid Artery

• Divides at the level of **upper border of thyroid cartilage**.
• Right side arises from brachiocephalic trunk; left from arch of aorta.

External Carotid Artery Branches

Mnemonic: **“Some Anatomists Like Freaking Out Poor Medical Students”**
• Superior thyroid
• Ascending pharyngeal
• Lingual
• Facial
• Occipital
• Posterior auricular
• Maxillary
• Superficial temporal

Internal Carotid Artery

• No branches in neck.
• Enters carotid canal ? supplies brain, eye, forehead.

Subclavian Artery Branches

• Vertebral artery
• Internal thoracic
• Thyrocervical trunk
• Costocervical trunk
• Dorsal scapular artery (variable)

Vertebral Artery

• Passes through **transverse foramina (C6 to C1)**.
• Enters cranial cavity through foramen magnum.

Clinical relevance

• Carotid pulse felt at anterior border of SCM.
• Carotid sinus hypersensitivity ? syncope.
• Vertebral artery compromise ? dizziness, ataxia.

Pharyngeal Apparatus

The pharyngeal apparatus consists of **arches, pouches, grooves (clefts)**, and **membranes**.

Pharyngeal Arches (Overview)

Each arch contains a **cartilage**, **artery**, **muscle**, and **cranial nerve**.

1st Arch (Mandibular Arch)

• **Nerve:** Trigeminal (V3)
• **Muscles:** Muscles of mastication, mylohyoid, anterior digastric, tensor tympani, tensor palati
• **Skeletal:** Malleus, incus, mandible template
• **Artery:** Maxillary artery

2nd Arch (Hyoid Arch)

• **Nerve:** Facial (VII)
• **Muscles:** Facial expression, stapedius, stylohyoid, posterior digastric

• **Skeletal:** Stapes, styloid process, lesser horn of hyoid
• **Artery:** Stapedial artery (embryonic)

3rd Arch

• **Nerve:** Glossopharyngeal (IX)
• **Muscles:** Stylopharyngeus
• **Skeletal:** Greater horn of hyoid
• **Artery:** Common carotid, proximal internal carotid

4th Arch

• **Nerve:** Superior laryngeal branch of vagus (X)
• **Muscles:** Pharyngeal constrictors, cricothyroid, levator palati
• **Skeletal:** Laryngeal cartilages (upper)
• **Artery:** Aortic arch (left), subclavian (right)

6th Arch

• **Nerve:** Recurrent laryngeal nerve (X)
• **Muscles:** Intrinsic laryngeal muscles (except cricothyroid)
• **Skeletal:** Laryngeal cartilages (lower)
• **Artery:** Pulmonary arteries, ductus arteriosus

Pharyngeal Pouches (Endoderm)

• **1st pouch:** Auditory tube + middle ear cavity
• **2nd pouch:** Palatine tonsil epithelium
• **3rd pouch:** Inferior parathyroids + thymus
• **4th pouch:** Superior parathyroids + ultimobranchial body (? C cells of thyroid)

Pharyngeal Grooves/Clefts (Ectoderm)

• **1st groove:** External auditory meatus
• Others disappear ? if persistent ? **branchial cysts/sinuses**

Pharyngeal Membranes

• **1st membrane:** Tympanic membrane
• Others disappear

Structures Derived from Components of Pharyngeal Arches

Each pharyngeal arch contains a **cartilage**, **muscle group**, **nerve**, and **artery**. Their derivatives are:

? 1st Pharyngeal Arch (Mandibular Arch)

Skeletal derivatives

• Maxilla
• Mandible (template)
• Zygomatic bone
• Part of temporal bone
• Malleus & Incus

Muscular derivatives

• Muscles of mastication
• Mylohyoid
• Anterior belly of digastric
• Tensor tympani
• Tensor palati

Nerve

• Mandibular division of trigeminal nerve (V3)

Artery

• Maxillary artery

? 2nd Pharyngeal Arch (Hyoid Arch)

Skeletal derivatives

• Stapes
• Styloid process
• Stylohyoid ligament
• Lesser horn & upper body of hyoid

Muscular derivatives

• Facial expression muscles
• Stapedius
• Stylohyoid
• Posterior belly of digastric

Nerve

• Facial nerve (VII)

Artery

• Stapedial artery (embryonic)

? 3rd Pharyngeal Arch

Skeletal derivatives

• Greater horn of hyoid
• Lower body of hyoid

Muscular derivatives

• Stylopharyngeus

Nerve

• Glossopharyngeal nerve (IX)

Artery

• Common carotid
• Proximal internal carotid

? 4th Pharyngeal Arch

Skeletal derivatives

• Laryngeal cartilages (upper part)

Muscular derivatives

• Cricothyroid
• Levator palati
• Pharyngeal constrictors

Nerve

• Superior laryngeal branch of vagus (X)

Artery

• Aortic arch (left)
• Right subclavian artery (right)

? 6th Pharyngeal Arch

Skeletal derivatives

• Laryngeal cartilages (lower part)

Muscular derivatives

• Intrinsic muscles of larynx (except cricothyroid)

Nerve

• Recurrent laryngeal branch of vagus (X)

Artery

• Pulmonary arteries
• Ductus arteriosus

Derivatives of Endodermal Pouches

? 1st Pouch

• Middle ear cavity
• Mastoid air cells
• Auditory (Eustachian) tube

? 2nd Pouch

• Epithelial lining of palatine tonsils

? 3rd Pouch

• **Dorsal wing ? Inferior parathyroid glands**
• **Ventral wing ? Thymus**

(Mnemonic: The 3rd pouch migrates further, so its parathyroids become “inferior.”)

? 4th Pouch

• **Dorsal wing ? Superior parathyroid glands**
• **Ventral wing ? Ultimobranchial body ? C cells of thyroid**

Derivatives of Ectodermal Clefts

? 1st Cleft

• External auditory meatus
• Outer surface of tympanic membrane

? 2nd–4th Clefts

• Normally obliterated by overgrowth of the 2nd arch
• Persistence ? **branchial cysts, sinuses, or fistulae** along anterior border of sternocleidomastoid

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Clinical Terms

• **Branchial cyst** – Persistent cervical sinus; found along anterior border of sternocleidomastoid.
• **Branchial fistula** – Persistence of a second cleft connection to pharynx.
• **DiGeorge syndrome** – Failure of **3rd and 4th pouches** ? absent thymus & parathyroids ?

hypocalcemia & immune deficiency.

• **Treacher Collins syndrome** – First arch neural crest defect ? mandibular hypoplasia, ear anomalies.

• **Pierre Robin sequence** – 1st arch defect ? micrognathia, glossoptosis, cleft palate.

• **Thyroglossal cyst** – Persistence of thyroglossal duct, midline swelling.

• **Laryngomalacia** – Soft laryngeal cartilages (arch 4 & 6 involvement).

• **Choanal atresia** – Failure of oronasal membrane to rupture; neonates present with cyanosis relieved by crying.

Molecular Regulation of Pharyngeal Arches

The development of pharyngeal arches depends on coordinated signalling between neural crest, mesoderm, endoderm, and ectoderm.

Key molecular regulators

• **Hox genes**
– Establish cranio-caudal patterning of arches (absent in 1st arch).

• **FGF (Fibroblast Growth Factors)**
– Essential for formation and survival of arch mesenchyme.

• **BMP (Bone Morphogenetic Proteins)**
– Patterning of skeletal elements; high BMP drives cartilage differentiation.

• **SHH (Sonic Hedgehog)**
– Governs outgrowth of facial processes; regulates neural crest migration.

• **Endothelin-1**
– Key regulator for **mandibular arch (1st arch)** patterning.

• **PAX genes**
– Important for segmentation and cranial neural crest differentiation.

• **Retinoic acid**
– Too little or too much disrupts pharyngeal apparatus (causes arch defects).

? SPOTS (Page 359)

(from the section labeled *HEAD AND NECK SPOTS*)

1.

a. Identify the foramen.
? Foramen magnum
b. Structures passing through it:

- Lowest part of medulla oblongata
- Three meninges
- One anterior spinal artery
- Two posterior spinal arteries
- Two vertebral arteries
- Spinal root of accessory nerve

2.

a. Identify the foramen.
? Mandibular canal
b. Structures passing through it:

- Inferior alveolar artery
- Inferior alveolar nerve

3.

a. Identify the muscle.
? Orbicularis oculi
b. Parts:

- Orbital part
- Palpebral part
- Lacrimal part

4.

a. Identify the circled structure.
? Chorda tympani nerve
b. Types of fibres carried:

- General visceral efferent (GVE)
- Special visceral afferent (taste)

5.

a. Identify the highlighted structure.
? Parotid gland
b. Secretomotor pathway:
Inferior salivatory nucleus ? Glossopharyngeal nerve (IX) ? Tympanic plexus ? Lesser petrosal nerve ? Otic ganglion ? Auriculotemporal nerve ? Parotid gland

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6.

a. Identify the structure.
? External carotid artery
b. Branches (in order):

- **Anterior:** Superior thyroid, Lingual, Facial
- **Medial:** Ascending pharyngeal
- **Posterior:** Occipital, Posterior auricular
- **Terminal:** Maxillary, Superficial temporal

7.

a. Identify the marked area.
? Little's area (Kiesselbach's plexus region)
b. Vessels present:

- Superior labial
- Greater palatine
- Anterior ethmoidal
- Sphenopalatine
  (Capillaries + venous plexus)

8.

a. Identify the structure.
? Tongue
b. Extrinsic muscles with nerve supply:

- Palatoglossus ? Vagus (via pharyngeal plexus)
- Hyoglossus ? Hypoglossal nerve

- Styloglossus ? Hypoglossal nerve
- Genioglossus ? Hypoglossal nerve

9.

a. Identify the muscle.
? Posterior cricoarytenoid
b. Action:
Only abductor of the vocal cords

10.

a. Identify the organ.
? Palatine tonsil
b. Arterial supply:

- Ascending palatine artery
- Ascending pharyngeal artery
- Dorsal lingual arteries
- Greater palatine artery

? ANSWERS OF SPOTS

These answers are exactly the same as above—page 360 is the printed “Answers” page that corresponds to the same items.
Everything from **1 to 10** already retrieved and presented above matches the answers section.