Lecture 17 - Nasal and oral cavities, tongue, salivary glands, taste, olfaction

Suprahyoid muscles (Moore pp 1012-1015, Netter Plate 24/47/53)
The suprahyoid muscles are located in the submental and submandibular triangle regions. The submandibular triangle is between the inferior mandible, and anterior & posterior bellies of the digastric muscle. The submental triangle is the chin area, bounded inferiorly by the hyoid bone and laterally by the right and left digastric muscles (anterior belly).

The suprahyoid muscles are located superior to the hyoid bone. They + innervation are: mylohyoid (Mylohyoid nerve coming of inferior alveolar nerve (CNV3), geniohyoid (C1 via hypoglossal n.), stylohyoid (Cervical branch of facial nerve), digastrics (anterior belly by mylohyoid m., posterior belly by facial n.). The mylohyoid forms the floor of the mouth & tongue, geniohyoid is superior to mylohyoid, stylohyoid is parallel to posterior belly of digastric muscle, and digastrics (anterior + posterior bellies connected by an intermediate tendon).

Together the suprahyoid muscles raise the mouth and tongue during swallowing. They also stabilise and lower the mandible.

Oral Cavity (Moore pp 927 Fig 7.46, Netter Plate 45)
The oral cavity has two subdivisions: oral cavity proper, and oral vestibule. The oral vestibule is between the teeth buccal gingiva and is connecting with the oral orifice. The oral cavity proper is bounded by the tongue inferiorly, maxillary and mandibular alveolar arches laterally + anteriorly, palate superiorly, oropharynx posteriorly.

Teeth (Moore pp 930 Netter Plate 50)
Teeth are gomphosis joints (a type of fibrous joints) between the teeth itself, and the alveolar process of the mandible or maxilla. Children have 20 primary teeth and adults have 32 secondary teeth. The number/type of teeth in adults is as follows: 4 * (2 incisors (medial + lateral), 1 canine, 2 premolars, 3 molars). A tooth can be split up into: crown (portion outside the gingiva), neck (between crown and root) and root (fixed in peridontal membrane). The tooth is made of dentin, which is covered by enamel (crown) and cement (root). The pulp cavity contains connective tissue, blood vessels and nerves. The root canal transmits the nerves and vessels to and from the pulp cavity.

Salivary glands: parotid (Moore pp 870 Fig 7.13, Netter Plate 19/48)
The parotids are the largest of the three salivary glands. The parotid duct exits at the anterior edge of the parotid and passes superficially over the masseter. It then turns medially at the masseter edge to pierce the buccinator muscle. The structures within the parotid from superficial to deep include: facial nerve and branches, retromandibular vein, external carotid artery + nerve plexus (Fig 7.13). The parotid gland has many relations (refer to Notes).

Salivary glands: submandibular (Moore pp 1013, Netter Plate 41/55)
The submandibular gland lies within the submandibular triangle. The submandibular duct passes parallel to the tongue to open into the oral cavity at the sublingual caruncle (with opening of submandibular duct). It too has many relations (refer to notes and Netter Plate 55).
Salivary glands: sublingual (Moore pp 948 Netter Plate 55/53/65)
The sublingual salivary glands are the smallest of the three salivary glands. It is deeply situated in the sublingual region. It is situated between the mandible and genioglossus muscle. The relations of this gland include: mandible, genioglossus muscle, tongue, submandibular duct, lingual nerve, hypoglossal nerve & sublingual vessels.

Openings of salivary glands (Moore pp 948/1013/870 Netter Plate 45/55)
The parotid duct pierces the buccinator muscle after leaving the medial edge of the masseter muscle (Netter Plate 48) and travels to open into the oral cavity at the parotid papilla (Netter Plate 45). The submandibular duct enters the oral cavity at the sublingual caruncle (papilla) located just lateral to the frenulum of tongue (Netter Plate 45). The sublingual duct opens into the oral cavity along the floor of the mouth (visible anteriorly) along the sublingual folds.

Parasympathetic innervation of submandibular and sublingual glands (Moore 948 Netter Plate 65)

The parasympathetic fibres innervating the submandibular and sublingual glands are secretomotor fibres – help secrete saliva. The preganglionic parasympathetic cell bodies are located in the superior salivatory nucleus in the caudal pons. The parasympathetic fibres exit with the facial nerve and its branch chorda tympani, which runs along the petrous part of the temporal bone. The chorda tympani nerve joins the lingual nerve (V3). Preganglionic fibres synapse at submandibular ganglion, postganglionic fibres travel with arteries directly or with lingual nerve to reach the glands.

Parasympathetic innervation of parotid gland (Moore pp 870 Netter Plate 119)
The parotid gland receives many nerve supply including: auriculotemporal nerve & great auricular nerve. The parasympathetic innervation is responsible for the secretory function. Preganglionics are located in the inferior salivatory nucleus in the rostral medulla and exit as CN IX (Glossopharyngeal nerve) and enter the tympanic nerve without synapsing in the superior + inferior ganglia of CN IX. Preganglionics travel through the tympanic plexus (in the tympanic cavity) and travel via the lesser petrosal nerve. These fibres synapse at the otic ganglion. Postganglionic parasympathica fibres travel to the gland via the auriculotemporal nerve (a branch of CNV_3).

Tongue muscles (Moore pp 940 Netter Plate 52)
The tongue is essentially a muscular organ. The muscles that comprise the tongue are made up of intrinsic and extrinsic fibres. Extrinsic muscles alter the position of the tongue, whilst intrinsic muscles alter its shape.

Extrinsic muscles: 1) genioglossus muscle fans out from the superior part of the mental spine of the mandible attaching to the inferior tongue. It acts to protrude the tongue. 2) hypoglossus – a quadrilateral muscle depresses the tongue. 3) styloglossus arises from the styloid process, passing inferoanteriorly to insert into the side and inferior tongue, it acts to elevate and retract the tongue. 4) palatoglossus muscle arises from the soft palate and inserts into the side of the tongue, acts to pull down soft palate.

Intrinsic muscles: 1) superior longitudinal muscle (just below mucosa), 2) inferior longitudinal: runs along inferior tongue, 3) transverse muscles of tongue, deep 1), 4) vertical muscle of tongue.

Innervation of tongue muscles: hypoglossal nerve - CN XII (Netter Plate 122)
All extrinsic and intrinsic muscles of the tongue except for palatoglossus are innervated by hypoglossal nerve – CN XII. Lower motor neurons innervating the tongue muscles arise from the hypoglossal nucleus in the medulla.

Course of hypoglossal nerve to tongue (Moore pp 1109, Netter Plate 122)
The hypoglossal nerve (CN XII) exits the brain stem at pre-olivary sulcus (Netter Plate 108) and exits the cranial cavity via hypoglossal canal (Netter Plate 7). It descends lateral to carotid sheath and loops anteriorly lateral to external and internal carotid arteries. It passes inferiorly medial to the angle of the mandible, lateral to hypoglossus and medial to submandibular gland, to enter the tongue.

UMN control over hypoglossal nucleus LMNs: Corticobulbar tract (Refer to Overview Lecture).

Damage to UMNs vs. LMNs for tongue (Notes)
Because the UMNs of the corticobulbar tract supply LMNs bilaterally, any UMN lesion (unless both) will not affect the tongue's LMN control (i.e.: fibres cross midline at medulla and serve the hypoglossal nucleus). LMN lesions will cause problems. The tongue is divided along the midline. Thus any LMN lesion will cause ipsilateral (i.e.: fibres already crossed before supplying the hypoglossal nucleus) tongue paralysis – atrophies with time. When you protrude your tongue, then the tongue will protrude to same side as lesion (i.e.: the lesioned side is now weaker, so the other side dominates).

Taste (gustatory) sensation (Moore pp 944 Netter Plate 52)

Taste sensation for the anterior 2/3 of the tongue is provided by the chorda tympani nerve, a branch of the facial nerve (VII). The lingual nerve supplies general sensation (touch, temperature), a branch of V_3. The posterior 1/3 of the tongue is supplied by the lingual branch of the glossopharyngeal nerve (IX). Taste receptors are sparsely located in the epiglottis and pharynx and these are supplied by the vagus nerve (CN X). Primary sensory cell bodies of taste fibres are located in geniculate ganglion, petrosal and nodose ganglion (Nolte 5th Ed pp 322 Fig 13-3). These fibres project to the nucleus of the solitary tract (caudal pons + rostral medulla) – where 2nd sensory neuron cell bodies are located (Nolte 5th Ed pp 324 Fig 13-5).

Taste (gustatory) sensation (Nolte 5th Ed pp 324 Fig 13-5)
Some ipsilateral projections from the nucleus of solitary tract travel to the parabrachial nucleus located in the pontine taste area. Third order neurons here project to the ventroposteromedial nucleus of thalamus, via the ipsilateral central tegmental tract. Fourth order neurons from the thalamus project to the gustatory cortex, located in the insula postcentral gyrus (primary somatosensory cortex). The gustatory cortex, in turn, projects to the orbital cortex of frontal lobe. Here taste information is thought to be integrated with olfactory information. From here it projects to the amyygdala → hypothalamus and limbic system.

General sensation (pain, temp, touch) from tongue (Moore pp 944)
The anterior 2/3 of the tongue is supplied by the lingual nerve, a branch of V_3. The posterior 1/3 of the tongue is supplied by the lingual branch of the glossopharyngeal nerve (CN IX). This nerve also does special sensation (taste). Primary sensory neurons are located in the trigeminal and petrosal ganglia. Fibres from here project to the spinal trigeminal nucleus and main sensory nucleus. Third order neurons from here cross the midline to become the trigeminothalamic tract, which ascends to the thalamus. Post-synaptic fibres from here project to the primary somatosensory cortex.

Glossopharyngeal nerve (CN IX) (Nolte 5th Ed pp 313 Netter Plate 119)
The glossopharyngeal nerve (CN IX) emerges from the medulla and exits the skull through the jugular foramen. It then follows the stylopharyngeus muscle and passes between the superior and middle constrictor muscles to enter the oral cavity. It supplies efferent fibres to the stylopharyngeus and parotid gland, and is afferent from the tongue and pharynx. It supplies general and special sensation (taste) to the poster 1/3 of the tongue. It sends off a branch to the carotid sinus and body.

Blood supply of tongue (Moore pp 944 Fig 7.58, Netter Plate 53)
Blood supply to the tongue is by the lingual artery, branching off from the external carotid artery. It passes deep to the hypoglossus muscle, and gives off three main branches: dorsal lingual artery and vein, deep lingual artery and vein, and sublingual artery and vein (sublingual glands). The lingual veins terminate in the IJV.

Lymphatic drainage of tongue (Moore pp 944)
The anterior 2/3 of the tongue drains to the: submental, submandibular nodes → then to deep cervical nodes. The posterior 1/3 of the tongue drains to superior and inferior deep cervical nodes. The central part of the tongue drains to both sides via the above mentioned nodes.

External nose (Moore pp 953 Fig 7.65A/B, Netter Plate 31)
Identify the following on a nose: dorsum, root, apex, ala, naris (nostrils). The bony skeleton of the external nose is formed by: nasal bones, frontal processes of maxilla, and nasal part of frontal bone. The cartilaginous skeleton is formed by: septal cartilage with lateral processes, major alar cartilages (medial + lateral crus), minor alar cartilage, and accessory nasal cartilage.

Nasal Cavity (Moore pp 954 Fig 7.67, Netter Plate 32)
Identify the following components of the nasal cavity: nasal vestibule (just above naris – lined by skin), posteriorly continuous with the pharynx through the choanae, nasal conchae (superior, middle, inferior). The respiratory region is the inferior 2/3 of the nasal cavity, whilst the superior 1/3 is the olfactory area. The mucosa covering the nasal cavity is continuos with all the other chambers it communicates with: nasopharynx, paranasal sinuses (frontal,

ethmoidal, sphenoidal, maxillary), lacrimal sac, conjunctiva. The mucosa of the respiratory area serves to warm and humidify the inspired air. The mucosal epithelium consists of cilia, which continuously clear the mucous away posteriorly into the nasopharynx.

Nasal septum (Moore pp 953)
The nasal septum divides the nose into two nasal cavities. The bony part is composed of: vomer, perpendicular plate of the ethmoid bone. The cartilaginous part is composed of: septal cartilage, medial crus of major alar cartilage.

Lateral nasal wall (Moore pp 956 Netter Plate 32)
Identify the following structures of the lateral nasal wall: the bony contributions from – maxilla, ethmoid, lacrimal, palatine, inferior nasal conchae. The nasal cavity is divided vertically by the superior, middle and inferior nasal conchae. The entrance passages to these are: superior, middle, and inferior nasal meatuses - respectively. The function of the conchae is to increase the SA of the nasal mucosa, therefore aiding in the warming and humidification of inspired air.

Paranasal air sinuses (Moore pp 957, Netter Plate 43)
The paranasal air sinuses are extensions of the respiratory part of the nasal cavity. They are also covered by mucosa. They extend into the cranial bones: maxillary, ethomoid, sphenoid, frontal. The sinuses are: frontal, maxillary, sphenoid, ethmoid (consists of air cells).

The frontal sinuses (paired) are located just posterior to the root of the nose. Each sinus drains into their respective nasal cavities via the frontonasal duct into the infundibulum – located in the middle meatus.The sphenoid sinuses are within the body of the sphenoid – just inferior and anterior to pituitary fossa (very fine bone separation). It derives from 1 posterior ethmoidal cell. They open into the nasal cavity via the sphenoethmoidal recess. The maxillary sinuses is the largest of them all: located within the body of the maxilla. It drains into the middle meatus via the maxillary ostium. The ethmoidal sinuses are diffusely located – called air cells. These cells are divided into three regions: anterior, middle, and posterior. The anterior cells drain into the infundibulum. The middle cells drain into the middle meatus, while the posterior cells drain into the superior meatus.

Palate (Moore pp 934 Netter Plate 57)
The palate separates the oral cavity from the nasal cavity. It also partially separates the nasopharynx from the oropharynx. The superior surface of the palate is respiratory mucosa; the inferior surface is the oral mucosa. The hard palate has a bony skeleton. This skeleton is afforded by the palatine process of the maxilla, and the horizontal plate of the palatine bone.

Muscles of the soft palate (Moore pp 935 Netter Plate 59)
The hard palate continues posteriorly to become the soft palate, although this part does not have any bony skeleton. The hard palate becomes the soft palate through the *aponeurotic plate.* The uvula hangs from the soft palate, on the posterior aspect. The soft palate has muscles attaching to it, therefore controlling it. These are: Levator veli palatini, tensor veli palatini, palatoglossus, palatopharyngeus, and musculus uvulae. The innervation of all these muscles (except for tensor veli palatini) is by Vagus nerve (CN X). The tensor veli palatini is innervated by V_2 (Check with Derek – lectures said V_3).

If there is a unilateral lesion of LMN of CN X – then the uvula will deviate to the unaffected side (i.e.: too much innervation on one side, and none on the other). The soft palate will droop slightly on the affected side.
General sensory innervation of nasal cavity and palate (Moore pp 940, Netter Plate 65)
General sensory innervations of the palate are all branches of the pterygopalatine ganglion (Fig 7.54, Moore pp 939). These are mostly branches of V_2. The greater and lesser palatine nerves, posterior lateral nasal branches, & nasopalatine nerve. Some branches also from V_1: internal nasal branches from nasociliary division of V_1. Main take home message is sensory innervation of the palate and nasal cavity is mainly by $V_1 + V_2$.

Parasympathetic innervation of nasal cavity and palate (Notes, Netter Plate 117)
Parasympathetic fibres originate from the superior salivatory nucleus (caudal pons) located in the reticular formation near internal genu of facial nerve (CN VII). Parasympathetic fibres exit

via the facial nerve (internal acoustic meatus) → greater petrosal nerve → joins the deep petrosal nerve from internal carotid plexus. It travels together with the sympathetics from here – vidian nerve, to synapse at the pterygopalatine ganglion. Post ganglionic parasympathetics travel to the glands of nasal cavity and palate via branches of V_2.

Blood supply of nasal cavity and palate (Moore pp 934/954 Fig 7.52, Netter Plate 63)
The palate has a rich blood supply – all deriving from the maxillary artery. The descending palatine artery comes off the maxillary artery, and gives off the greater palatine artery. The lesser palatine artery, also a branch of the descending palatine artery, anastomoses with the ascending palatine artery (a branch of the facial artery). The sphenopalatine artery (branch from maxillary artery) gives off posterior lateral + septal arteries.

The ophthalmic artery – also supplies parts of the nasal cavity. The anterior and posterior ethmoidal arteries form a network of anastomoses to supply the nasal cavity. The facial artery also gets involved with its branches: superior labial and lateral nasal arteries.

Olfaction (smell) (Nolte 5th Ed pp 325, Fig 13-15, 13-16, Netter Plate 113)
The nasal cavity is divided into two main regions. The superior 1/3 is responsible for olfaction – olfactory epithelium (Fig 13-8 of Nolte 5th Ed). The inferior 2/3 is responsible for warming and humidifying the air – respiratory epithelium. Olfaction is mediated by bipolar receptor cells – whose axons join the other olfactory neuron axons – forming the olfactory nerve. There are about 20 olfactory nerves altogether (CN I). These nerves pass through the cribiform plate of the ethmoid bone to synapse in the olfactory bulb. These olfactory nerves are extremely fragile, so trauma may sever these nerves – anosmia – loss of smell – reduced taste sensation.

Olfaction (smell) (Nolte 5th Ed pp 325 – same Figures)
There are about 5 million receptor neurons in each region of the olfactory mucosa – and each of these receptor neurons expresses 1 odorant receptor. There are about 1000 different odorant receptors expressed by all the receptor cells. The receptor neurons sends their axons which synapse in the olfactory bulb. The primary cell here is the mitral cell – which has a triangular cell body. The axons comes from the apex and moves into the olfactory bulb, while the dendrites emerge from the base and arise onto the surface of the bulb. The dendrites are arranged in glomeruli – so all the olfactory neurons expressing a particular odorant receptor will project to just 1-3 of them. Thus, activation of different collections of glomeruli – means a particular sense is stimulated. There are also other cells present in the bulb – granule cells (interneurons), and tufted cells (small mitral cells). The axons of the mitral cells travel caudally as the olfactory tract – and project to the primary olfactory cortex (inferomedial part of temporal lobe) ipsilateral. Therefore no thalamus input required (unique one). From the olfactory cortex – projects to the hypothalamus, limbic system and to the dorsomedial nucleus of thalamus.