Introduction
The major salivary glands: parotid, submandibular, and sublingual glands, are paired and symmetric. In the oral cavity 700–900 minor salivary glands are found, the majority of which are located at the junction of the hard and soft palates. In this chapter, anatomic relations of the main salivary glands are shown in a layered fashion.

Parotid Gland
Location
The face (Fig. 1.1) is divided into two main compartments: the superficial compartments dedicated to mimicry and innervated by the facial nerve; and the deep visceral compartment innervated by the other cranial nerves. The superficial compartments are constituted by five layers: (1) skin; (2) subcutaneous tissue including fat and tela-retinaculum cutis (Fig. 1.2); (3) submuscular aponeurotic system (SMAS) (Fig. 1.3); (4) deep facial space; (5) deep facial fascia. The parotid gland is in the visceral compartment (Fig. 1.4), under the deep facial fascia, i.e., deep to the 5th superficial compartment layer.

It lies within a deep hollow, known as the parotid region. The parotid region is bounded by: superiorly–zygomatic arch; anteriorly–masseter muscle and mandible bone (Fig. 1.5); posteriorly–external ear tragal cartilage and sternoclavicular muscle; inferiorly, the inferior parotid pole is between the ramus of the mandible and sternocleidomastoid muscle overlying the digastric muscle (Fig. 1.5). The deep aspect rests in the prestyloid compartment of the parapharyngeal space (Fig. 1.6).

Description
Shape
The parotid gland is a bilateral prismatic structure that looks like an inverted three-sided pyramid, which displays a lobular and irregular morphology (Fig. 1.1). It presents at four surfaces: superior, superficial, anteromedial, and posteromedial; separated by three borders: anterior, posterior, and medial.

Constitution
Anatomically, the parotid can be divided into deep and superficial lobes, which are separated by the facial nerve. Approximately 80% of the parenchyma is located as superficial lobe.

Vascularization and Innervation
Vasculature
Blood is supplied by the posterior auricular and superficial temporal arteries. They are both branches of the external carotid artery, which arise within the parotid gland (Figs. 1.7, 1.8).

Venous drainage is achieved via the retromandibular vein. It is formed by unification of the superficial temporal and maxillary veins (Figs. 1.7, 1.8).

Innervation
The parotid gland receives sensory and autonomic innervation. The autonomic innervation controls the rate of saliva production. Sensory innervation is supplied by the auriculotemporal nerve (gland) and the great auricular nerve. The parasympathetic innervation to the parotid gland has a complex path. It begins with the glossopharyngeal nerve (cranial nerve IX). This nerve synapses with the otic ganglion (a collection of neuronal cell bodies). The auriculotemporal nerve then carries parasympathetic fibers from the otic ganglion to the parotid gland. Parasympathetic stimulation causes an increase in saliva production.

Sympathetic innervation originates from the superior cervical ganglion, part of the paravertebral chain. Fibers from this ganglion travel along the external carotid artery to reach the parotid gland. Increased activity of the sympathetic nervous system inhibits saliva secretion, via vasoconstriction.

Anatomic Relationships
The Parotid Bed
The gland is embedded in its capsule and the parotid-masseteric fascia (layer 5), which attaches to the root of the zygoma and continues as a thin fascia that can be separated from tragal and conchal cartilage by blunt dissection. A
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The Facial Nerve (Cranial Nerve VII)
The extratemporal segment exits the skull base through the stylomastoid foramen posterolateral to the styloid process and anteromedial to the mastoid process. The facial nerve as it enters the parotid forms the pes anserinus (Figs. 1.7–1.10). The upper divisions include the temporal–facial branches and the lower divisions include the cervico-facial branches. These branches innervate the muscles of facial expression.

The anatomic landmarks identifying the facial nerve in antegrade fashion are: (1) the tympano-mastoid suture is the direction landmark, as it shows the direction of the stylomastoid foramen, located ~2 mm superior to the facial nerve; (2) the posterior belly of the digastric is the depth landmark, located 1 cm inferior to the facial nerve (Fig. 1.5); (3) the tragal cartilage “pointer” indicates the location

thick fascia is attached to the periosteum of the mastoid process and tympano-mastoid suture, the so-called Loré’s fascia. A thick fascia at the antero–inferior tip of the parotid separates it from the submandibular gland. Anteriorly, this parotid-masseteric fascia extends to the buccinator aponeurosis, embedding Stensen’s duct until its penetration through the buccinator muscle (Fig. 1.4).

**Fig. 1.1** The parotid gland has a lobular morphology.

**Fig. 1.2** The superficial surface, subcutaneous tissue, and fat.

**Fig. 1.3** The submuscular aponeurotic system (SMAS) layer.

**Fig. 1.4** The parotid gland with Stensen’s duct (green marker). Inferior to Stensen’s duct and anterior to the parotid gland is the masseter muscle.
Retromandibular Vein
The retromandibular vein is formed within the parotid gland by the convergence of the superficial temporal and maxillary veins. It is one of the major structures responsible for venous drainage of the face. The retromandibular vein joins the external jugular vein via the posterior facial vein (Fig. 1.7). It can give off an anterior facial vein that joins the internal jugular vein that joins the internal jugular vein.

External Carotid Artery and Branches
The external carotid artery (ECA) courses medial to the parotid gland. Within the gland, the ECA gives rise to the posterior auricular artery. The ECA then divides into its two terminal branches: the maxillary artery and the superficial temporal artery. The superficial temporal artery gives off the transverse facial artery. Anteriorly and inferiorly the facial artery is visualized.

Great Auricular Nerve
The great auricular nerve is a superficial branch of the cervical plexus and contributed to by fibers from C2 and C3 spinal nerves. It leaves the cervical plexus at the posterior border of sternocleidomastoid muscle (Erb’s point). It courses superiorly, dividing into anterior and posterior branches. The posterior branch supplies the skin over the mastoid process and lower external ear and anterior branch of the facial nerve exit as it is located ~8 mm cranial to the foramen; (4) the styloid process is not considered as a surgical landmark as it is deeper and cephalic to the facial nerve; however, by digital palpation, it constitutes a helpful landmark.
sends a small twig into the substance of the parotid gland and connects to the facial nerve. The posterior branch can often be saved during parotid surgery, potentially reducing auricular numbness, as shown in Fig. 1.11.

**Submandibular Gland**

The submandibular gland (SMG) is one of the major salivary glands. Submandibular glands are bilateral and are located in the anterior part of the submandibular triangle, which is bordered by: superiorly, the inferior body of the mandible;
anteriorly, the anterior belly of the digastric muscle; posteriorly, the posterior belly of the digastric muscle; and medially, by the base by the hyoglossus muscle. Approximately 70% of total saliva is produced by submandibular glands. A submandibular gland weighs 7–12 g.

In this section, the location, vasculature, and innervation of the submandibular glands are discussed, and the relevant clinical correlations are demonstrated.

**Location**

Deep to the 5th soft tissues layer, embedded in a division of the deep cervical fascia (layer 5), the SMG is located under the mandible bone, bordered by the digastric and mylohyoid muscles and corresponds to the lateral mouth floor. SMGs are located at each side of the neck in the submandibular triangle, placed deep to the platysma muscle and anterior to the sternocleidomastoid muscle.

Morphologically, the submandibular glands are a pair of elongated, flattened hooks, which have two sets of lobes: superficial and deep. The positioning of these lobes is in relation to the mylohyoid muscle, which the gland hooks around.

The superficial lobe comprises the greater portion of the gland and lies partially inferior to the posterior half of the mandible, within an impression on its medial aspect (the submandibular fossa). It is situated outside the boundaries of the oral cavity.

The deep lobe hooks around the posterior margin of mylohyoid muscle through a triangular aperture to enter the oral cavity proper. It lies on the lateral surface of the hyoglossus, lateral to the root of the tongue.

**Description**

The SMG can be compared with a triangular almond, where the anterior border is divided by the mylohyoid muscle in two lobes: superficial and deep. Secretions from the submandibular glands travel into the oral cavity via the submandibular duct (Wharton's duct). This is approximately 5 cm in length and emerges anteromedially from the deep lobe of the gland between the mylohyoid, hypoglossus, and genioglossus muscles. The duct ascends on its course to open as one or two orifices on a small sublingual papilla (caruncle) at the base of the lingual frenulum bilaterally.

**Anatomic Relations**

**Submandibular Bed and Deep Cervical Fascia**

The lateral surface corresponds to the cervical soft tissues and to the surgical access. Skin (layer 1) (Fig. 1.12) and subcutaneous tissue (layer 2) (Fig. 1.13) consist of subcutaneous fat and tela-retinaculum cutis; the platysma muscle forms the SMAS for the SMG (layer 3) (Figs. 1.14, 1.15). It is divided into two main portions: the anterior mentalis portion inserted onto the mandible caudal border, and the lateral labialis portion that passes over the mandible and connects to the depressor anguli oris muscle and the modiolus. The subSMAS plane is an areolar plane, easy to undermine, in which the marginal mandibularis branch of the facial nerve is running (Fig. 1.16). The ramus marginalis mandibularis is running over the facial vascular pedicle – facial artery and facial vein that are still deep to the 5th layer (Fig. 1.17). In this layer are also running the branches of the cervical nerves, mostly the transverse branch that anastomoses with the cervical branch of the facial nerve (Fig. 1.18).

In the submandibular gland bed, the facial artery courses deeply between the posterior belly of digastric muscle and stylohyoid muscle. It enters to the gland capsule by the
Facial Vein
Venous drainage is through the submental veins, which drain into the facial vein and then the internal jugular vein. The facial vein lies superficial to the gland and to the artery; it does not enter the parenchyma.

Lingual Nerve
The lingual nerve is one of the main anatomic danger points during surgery. It provides secretory innervation to the
• Fig. 1.18 Marginal mandibularis branch of facial nerve (black markers) and inferior to it, branches of the cervical branch of the facial nerve, the transverse branches of facial nerve (black markers). The facial vein is shown with blue markers.

• Fig. 1.19 Submandibular gland partially removed. The marginal mandibularis branch of facial nerve (black marker) and facial vein (blue markers). The hypoglossal nerve is deep to the anterior belly of the digastric muscle.

• Fig. 1.20 The hypoglossal nerve runs deep to the anterior belly of the digastric muscle and superficial to the hyoglossus muscle. The carotid artery is posterior to the hypoglossal nerve.

• Fig. 1.21 The course of the facial artery and the submental artery. The submandibular gland is retracted inferiorly.
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SMG and sensory innervation to the tongue. Its injury causes hemi-tongue anesthesia (Fig. 1.22).

**Lymph Nodes**

Four groups of lymph nodes can be described – from anterior to posterior: preglandular, prevascular, retrovascular, and retroglandular.

**Relationship With Nerves**

Both the submandibular gland and duct share an intimate anatomic relationship with three main nerves: the lingual nerve, hypoglossal nerve, and facial nerve (marginal mandibular branch). The courses of these nerves are briefly outlined next.

**Lingual Nerve**

The lingual nerve is a sensory nerve that traverses the floor of the mouth. During submandibular gland surgery, it attaches to the deep superior surface of the submandibular gland via the submandibular ganglion (Fig. 1.22). Starting lateral to the submandibular duct, this nerve courses anteromedially by looping beneath the duct and then terminating as several medial branches. The terminal branches ascend on the external and superior surface of the hyoglossus muscle to provide general somatic afferent innervation to the mucous membrane of the anterior two-thirds of the tongue. During the ligation of Wharton’s duct in transcervical submandibular gland excision surgery, the duct crosses deep to the lingual nerve; it is important to avoid a nerve injury.

**Hypoglossal Nerve**

The hypoglossal nerve provides motor function to the tongue and it lies deep to the submandibular gland and runs superficial to hyoglossus muscle, protected by a tiny fascia deep to the digastric muscle. It lies medial to the common tendon of the digastric muscle. At this point, just posterior to the hypoglossal nerve, the facial artery traverses through the gland. During ligation of the facial artery, effort should be given not to injure the hypoglossal nerve.

**Facial Nerve**

The marginal mandibular branch of the facial nerve exits the anterior–inferior portion of the parotid gland at the angle of the mandible and transverses the margin of the mandible in the plane between platysma and the investing layer of deep cervical fascia curving down toward and sometimes inferior to the submandibular gland (Figs. 1.17, 1.18). In most cases, the nerve continues forward above the inferior border of the mandible deep to the masseteric fascia. It crosses the anterior facial artery to enter the buccal space, where it provides branches to the depressor anguli oris, the depressor labii inferioris, and mentalis muscles.

**Surgical Implications**

Dissection between platysma and deep cervical fascia may cause injury risk to the marginal mandibular nerve during surgical procedures such as submandibular gland excision or rhytidectomy. In transcervical submandibular gland excision the precautions start at the skin incision. An incision is made 4 cm inferior to the inferior border of the mandible and parallel to the neutral skin lines. The easiest way to protect the nerve is to open the SMG capsule and to proceed deep to this capsule through a subcapsular dissection. This subcapsular dissection also protects the hypoglossal nerve as it leaves the deep fascia overlying this nerve. Deep to platysma, the marginal mandibular nerve can be identified. Care must be taken by the assistant not to pull too vigorously upward, as that could result in a stretch injury. It is feasible to preserve marginal mandibular nerve by ligation of the posterior facial vein and reflect the investing fascia superiorly upward over the mandible.

**Sublingual Gland and Wharton’s Submandibular Salivary Duct**

The sublingual glands are the smallest of the three paired major salivary glands and the most deeply situated. Both glands contribute to only 3–5% of overall salivary volume, producing mixed secretions which are predominately mucous in nature.

**Location**

The sublingual glands are almond-shaped (ovoid) and lie on the floor of the oral cavity proper (Figs. 1.23, 1.24).
They are situated under the tongue, bordered laterally by the mandible and medially by genioglossus muscle. The glands form a shallow groove on the medial surface of the mandible known as the sublingual fossa. Medially, the submandibular duct and its lingual nerve relation pass immediately next to the sublingual glands between genioglossus (Figs. 1.25–1.28). Both sublingual glands unite anteriorly and form a single mass through a horseshoe configuration around the lingual frenulum. The superior aspect of this U-shape forms an elevated, elongated crest of mucous membrane called the sublingual fold (plica sublingularis).

Each sublingual fold extends from a posterolateral position and traverses anteriorly to join the sublingual papillae at the midline bilateral to the lingual frenulum.

Secretions drain into the oral cavity by minor sublingual ducts (of Rivinus), of which there are 8–20 excretory ducts per gland, each opening out onto the sublingual folds. Through anatomic variance, a major sublingual duct (of Bartholin) can be present in some people.

This large accessory duct arises from the inferior aspect of the sublingual gland and then adheres to the passing submandibular duct on its medial side. Drainage then follows the submandibular duct out through the sublingual papillae.

**Vasculature**

Blood supply is via the sublingual and submental arteries, which arise from the lingual and facial arteries respectively; both from the ECA.
Venous drainage is through the sublingual and submental veins, which drain into the lingual and facial veins, respectively; both then draining into the internal jugular vein.

**Innervation**

The sublingual glands receive autonomic innervation through parasympathetic and sympathetic fibers, which directly and indirectly regulate salivary secretions, respectively.

Their innervation is the same as that of the submandibular glands.