The Muscles of Mastication and of the Tongue – How They Allow us to Chew, Speak, and Swallow

Whether it is grinding food, chewing bubble gum, or moistening the lips with the tongue - we consciously and unconsciously use our jaw and tongue muscles every day. In this section you will find a compact overview of the properties of the tongue and the hyoid muscles as well as the functions, origins, and insertions of the four chewing muscles and the special features of the temporomandibular joint.

Tongue- and Hyoid Muscles
Human Tongue Muscles

The tongue muscles consist of

- intrinsic tongue muscles and
- extrinsic tongue muscles

**Intrinsic Tongue Muscles**

The intrinsic tongue muscles alter the shape of the tongue and are innervated by the hypoglossal nerve, cranial nerve XII. Their respective effect depends on simultaneous contraction of other intrinsic tongue muscles.

The tissue pressure that arises during contraction of the intrinsic tongue muscles works in an antagonistic manner along similar lines to a water cushion.

The intrinsic tongue muscles consist of the following muscles:

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior longitudinal</td>
<td>The <strong>superior longitudinal muscle</strong> originates from the <em>apex linguae</em> and inserts at the <em>radix linguae</em>. It can shorten and widen the tongue and elevate the tip of the tongue.</td>
</tr>
<tr>
<td>Inferior longitudinal</td>
<td>The <strong>inferior longitudinal muscle</strong> shortens andwidens the tongue and depresses the tip of the tongue. The origin and insertion are the same as in the <strong>superior longitudinal muscle</strong>.</td>
</tr>
<tr>
<td>Transverse</td>
<td>The origin and insertion of the <strong>transverse muscle of the tongue</strong> are the lateral edge of the tongue. It is responsible for narrowing and extending the tongue as well as arching the lateral edges of the tongue in an upward direction.</td>
</tr>
<tr>
<td>Vertical</td>
<td>The task of the <strong>vertical muscle of the tongue</strong> is to flatten, widen, and lower the tongue. It originates from the <em>lingual aponeurosis</em> and inserts at the lower surface of the tongue.</td>
</tr>
</tbody>
</table>

It can be difficult for some patients to perform certain movements ‘on command’. The activity under investigation can, however, be observed in between various other movements.
Note: Given a lesion of the hypoglossal nerve, the tip of the tongue deviates to the diseased side.

**Extrinsic Tongue Muscles**

The extrinsic tongue muscles have the task of moving the whole tongue in the oral cavity. Depending on the location of the muscle, the tongue can be moved forwards and backwards and also elevated and depressed.

There are five extrinsic tongue muscles:

<table>
<thead>
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<th>Muscle</th>
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<tr>
<td>Genioglossus muscle</td>
<td>The <strong>genioglossus muscle</strong> originates from the inner surface of the mandible and inserts at the <strong>lingual aponeurosis</strong>. The muscle pulls the tongue forwards and downwards. Like all the other extrinsic tongue muscles, it also moves the whole tongue in the oral cavity or even out of the cavity if the intrinsic tongue muscles simultaneously perform a longitudinal extension.</td>
</tr>
<tr>
<td>Hypoglossus muscle</td>
<td>The <strong>hypoglossus muscle</strong> has its origin at the <strong>major horn and the body of the hyoid bone</strong> and pulls the tongue base backwards and downwards, which moves food components towards the esophagus. This function immediately follows the initiation of the swallowing process by the <strong>styloglossus muscle</strong>. The <strong>hypoglossus muscle</strong> also inserts at the <strong>lingual aponeurosis</strong>, but on the lateral side.</td>
</tr>
<tr>
<td>Chondroglossus muscle</td>
<td>The <strong>chondroglossus muscle</strong> originates from the <strong>minor horn of the hyoid bone</strong> and runs to the <strong>lingual aponeurosis</strong>. In terms of its effect, it corresponds to the <strong>hypoglossus muscle</strong>.</td>
</tr>
<tr>
<td>Styloglossus muscle</td>
<td>The main task of the <strong>styloglossus muscle</strong> is to pull the tongue base backwards and upwards. As mentioned, its contraction initiates swallowing after chewing. The food is pushed against the palate so that the swallowing reflex is triggered. The muscle is also important for sucking motions: during sucking, the tongue is pulled back in the oral cavity like the piston of a syringe. It originates from the <strong>styloid process</strong> and inserts at the lateral edge of the tongue.</td>
</tr>
<tr>
<td>Palatoglossus muscle</td>
<td>The <strong>palatoglossus muscle</strong> elevates the tongue during swallowing. It originates from the <strong>palatine aponeurosis</strong> and radiates into the intrinsic tongue muscles.</td>
</tr>
</tbody>
</table>

Like the intrinsic tongue muscles, the **genioglossus, hypoglossus, chondroglossus**, and **styloglossus muscles** are innervated by the **hypoglossal nerve**. The **palatoglossus muscle** is however supplied by the **glossopharyngeal nerve** (**IX**) and the **vagus nerve**.

**Muscles of the Lingual Bone**

The lingual bone (Latin: **os hyoideum, hyoid bone**) serves as a support for the base of the tongue and is a hoof-shaped flat bone-brace. It is possible to feel it in the kink between the neck and the floor of the mouth. The hyoid bone can easily be moved back and forth since it rises and lowers every time a person swallows.

**Why is the hyoid bone so mobile?**

The **os hyoideum** is very motile since it does not have any direct contact to other bones. It inserts between the hyoid muscles like a bony intermediate tendon and is, additionally, fixed at the skull by means of ligaments.

The suprahyoid muscles insert from the head at the hyoid bone and the infrayhoid muscles insert from below.

**Suprahyoid Muscles**
The following muscles are part of the suprahyoid muscles:

- digastric muscle
- mylohyoid muscle
- stylohyoid muscle
- geniohyoid muscle

The floor of the mouth (Latin: *diaphragma oris*) extends – in the form of a muscle plate – from the hyoid bone to the inner surface of the mandible. The left and right floor of mouth muscles (the *mylohyoid muscle*) are united via an intermediate tendon (Latin: *raphe mylohyoidea*).

The *digastric muscle* has two bellies and lies on the outside of the mouth floor. It is connected to the hyoid bone by an intermediate tendon. The anterior belly (Latin: *venter anterior*) runs upwards obliquely and on to the inner surface of the chin. The posterior belly (Latin: *venter posterior*) runs upwards obliquely and backwards to the base of the skull.

Parallel to the *venter posterior*, the *stylohyoid muscle* also runs from the styloid process (Latin: *processus styloideus*) at the base of the skull to the *hyoid bone*.

Lying next to the median plane and running from front to back, the right and left *geniohyoid muscles* lie close together at the superior surface of the mouth floor. This is also referred to as the chin-hyoid bone muscle.

**Infrahyoid Muscles**
The following muscles are assigned to the infrahyoid group of muscles:

- the omohyoid muscle
- the sternohyoid muscle
- the sternothyroid muscle
- the thyrohyoid muscle

From the hyoid bone to the posterior surface of the manubrium sterni (part of the sternum), the infrahyoid muscles extend in the form of a straight strand on both sides of the midline.

The only exception is the omohyoid muscle (scapula-hyoid bone-muscle), which runs to the superior margin of the scapula under the sternocleidomastoideus muscle in the lateral cervical triangle. During powerful actions it appears temporarily as an oblique strand in the lateral cervical triangle.

Each of the other three muscles consists of three plates of strap-shaped muscles. The sternohyoid muscle is the longest of them. Together, the sternothyroid muscle and the thyrohyoid muscle form a consecutive muscle loop, which is as long as the sternohydoid muscle.

Functions of the Hyoid Muscles

During swallowing, the suprahyoid muscles pull the larynx, which is connected to the hyoid bone, against the posterior end of the tongue until the flexible epiglottis abuts, bends, and lies protectively over the entrance to the larynx (Latin: aditus laryngis). This is required to avoid anything being taken into the trachea. The larynx and the hyoid bone are then led back to their original position by the infrahyoid muscles.

As a connecting, free bone, the hyoid bone is inserted into a muscular loop, which consists of the suprahyoid and infrahyoid muscles. They form a synergistic muscular loop so that the hyoid bone can be fixed at the punctum fixum by means of counter resistance. This is implemented when the mouth is opened against resistance.

As the hyoid muscles keep the hyoid bone in position, the originating tongue muscles have a fixed point for the purpose of tongue movement.

During flexion of the cervical spine and the head, the hyoid muscles may contribute. If needed, the muscular loop of the tongue muscles can be used as respiratory muscles, which pull the sternum cranially.

**Note:** The hyoid muscles fulfill the following tasks:
- participation in the act of swallowing
- directing the movement of the mandible
- indirect participation in tongue movement
- opening the mouth against resistance
- participation in flexion of the cervical spine and the head
- respiratory muscles
- by means of the omohyoid muscle: keeping the major jugular vein open against the negative pressure produced by the heart, which is a suction pump.

Muscles of Mastication and Temperomandibular Joint

The **masseter muscle** is located in the posterior parts of the cheek and it covers the ascending ramus of the mandible as well as the **mandibular angle** from the outside. Along with the **temporal muscle** and the **medial and lateral pterygoid muscles** it is part of the chewing muscles, which belong together not only functionally, but also in evolutionary terms. They are innervated by the **mandibular nerve** of the **trigeminal nerve** (V).

Temporal Muscle

![Image: "Location of temporal muscle" by Was a bee. License: CC BY-SA 2.1 JP](image)

It is often difficult to look at the **temporal muscle** without considering their main synergists, the **masseter muscle** and the **medial pterygoid muscle**.

The muscle expands across the major part of the lateral wall of the skull. Its posterior and superior borders are marked by the **inferior temporal line**. The muscle reaches its greatest thickness behind the **zygomatic bone**. In a horizontal section the muscle would look like a triangle extending over the cheekbone, whereas at the front a wide base would be seen and at the back a long tip which peters out would be seen.

The **temporal muscle** originates from the **temporal fossa** and is covered by two layers of fasciae. The superficial fascia consists of a loose layer of connective tissue. Beyond the
temporal plane, it grows firm against the periost. However, the deep temporal fascia has an aponeurosis-character and also expands over the temporal muscle.

The muscle is shaped like a fan in which the anterior and deep fibers run almost vertically, or, rather, medially from the front in lateral and posterior directions. The posterior fibers run in a horizontal direction. The muscle fibers bunch into a tendon during their course, and this tendon inserts at the coronoid process of the mandible.

Functions of the Temporal Muscle

The temporal muscle facilitates powerful biting and it can simultaneously also pull the mandible backwards by means of its horizontal fibers.

Depression of the mandible due to gravity is inhibited by its continuous tone.

Note: The temporal muscle is often involved in the development of a tension headache or Costen’s syndrome.

Masseter muscle

The shape of the masseter muscle is often compared to a rectangle with a rounded bottom corner.

Superficially, the muscle is divided into two portions. The larger, rectangular, anterior part of the masseter muscle that runs obliquely (the superficial part) originates from the zygomatic process of the maxilla, and from the anterior two thirds and the inferior surface of the zygomatic arch. The deep part of the masseter muscle originates from the posterior two thirds, from the inferior surface, and the medial surface of the zygomatic arch.

With respect to its superficial part, it extends to the mandibular angle and the masseteric tuberosity, and to the outer surface of the mandibular ramus with respect to its deep part.
Functions of the Masseter Muscle

The **masseter muscle** facilitates powerful closing of the jaw. It can also move the mandible forwards by means of its **superficial part** and backwards with its **deep part**.

These accompany the **medial pterygoid muscle** during movement.

**Note:** In the case of paralysis of the **masseter muscle**, the function of this muscle can be performed by the **medial pterygoid muscle** and the **temporal muscle**. A spastic reaction pattern can result from a skull/brain trauma, with another consequence being that it becomes more difficult to open the mouth; it also leads to severe teeth grinding (bruxism).

Medial Pterygoid Muscle

The **medial pterygoid muscle** lies at the medial side of the mandible in the form of a mirror image of the **masseter muscle**.

It originates from the pterygoid fossa of the sphenoid bone and from the **lateral lamina** of the **pterygoid process** and runs back to the inner surface of the **mandibular angle** and the **pterygoid tuberosity**.

It is significantly narrower than the masseter and is shaped like a narrow rectangle.

The Function of the Medial Pterygoid Muscle

The **medial pterygoid muscle** closes the jaw in a powerful manner. It is able to pull the mandible slightly forwards and sideways.

Lateral Pterygoid Muscle

The **lateral pterygoid muscle** expands at the **infratemporal fossa**. The course of the horizontally running fibers significantly differs from the course of the other jaw adductors.

The upper part of the **pterygoid muscle** originates from the **temporal surface** of the **major wing of the sphenoid bone**, and the lower part originates from the lateral surface of the **lateral lamina** of the **pterygoid process**. The upper part inserts at the **pterygoid fovea** of the **condylar process** and at the anterior margin of the **articular disc** of the temporomandibular joint. The insertion of the lower part of the **lateral pterygoid muscle** is the **pterygoid fovea** of the **condylar process**.
Functions of the Lateral Pterygoid Muscle

The lateral pterygoid muscle is an important opener of the jaw. Extending from the front, it inserts at the mandible and can pull the mandible itself and the disc of the temporomandibular joint forwards.

In summary, one should know the following functions of the muscles of mastication:

Masseter muscle:
- elevation of the mandible
- protrusion of the mandible
- slight lateral sideways movement of the mandible during unilateral contraction

Temporal muscle:
- elevation of the mandible
- retraction of the mandible
- slight protrusion of the mandible
- slight lateral sideways movement of the mandible during unilateral contraction

Medial pterygoid muscle:
- elevation of the mandible
- protrusion of the mandible
- medial sideways movement of the mandible during unilateral contraction

Lateral pterygoid muscle:
- protrusion of the mandible
- depression of the mandible
- medial sideways movement of the mandible during unilateral contraction

Temporomandibular Joint

The temporomandibular joint is one of the ‘connected flexible’ bone joints and it represents a closed sequence of joints.

The condylar process of the mandible and the mandibular fossa of the temporal bone form the temporomandibular joint.

Anteriorly, the mandibular fossa is bordered and stiffened by the articular tubercle and, posteriorly, by the retroarticular process, which is small in humans. It is only covered by fibrocartilage at the front.

The shape of the condyle of the mandible fits the articular fossa and has an ellipsoid form, which is somewhat broader laterally than medially. Furthermore, its upper, anterior
The articular surface is more inclined to the outside and is covered with fibrocartilage. The dorsal articular surface descends to the posterior in a flat manner and it is only covered by dense connective tissue.

The articular disc separates the head and socket from each other so that two completely separate articular cavities exist. The disc is a trapezoid body, which is thickened at both its longitudinal sides and whose middle narrow zone is very thin. In the inferior articular cavity, the articular head of the jaw moves in a rotating movement around a frontal or vertical axis, while a sliding movement occurs between the disc and the mandibular fossa in the superior articular cavity.

Movement of the Temporomandibular Joint

Due to the type of movement made by the temporomandibular joint, it is referred to as a mixed joint, with four degrees of movement.

The main movements are classified as follows:

- hinge-like elevation and lowering of the mandible around a horizontal axis
- grinding movements - i.e. rotation of the mandible around a vertical axis
- protrusion and retraction along a sagittal axis

Note: Lockjaw occurs if the head of the mandibular joint moves in front of the articular tubercle when the mouth is wide open, such that it is thereby caught in this position so
that the mouth is no longer able to close.

Popular exam questions relating to the muscles of mastication and of the tongue

The answers can be found below the references.

1. Which of the following form the intrinsic tongue muscles?
   A. Superior longitudinal muscle, inferior longitudinal muscle, genioglossus muscle, hypoglossus muscle
   B. Superior longitudinal muscle, inferior longitudinal muscle, transverse muscle of the tongue, vertical muscle of the tongue
   C. Chondroglossus muscle, styloglossus muscle, transverse muscle of the tongue, vertical muscle of the tongue
   D. Superior longitudinal muscle, palatoglossus muscle, transverse muscle of the tongue, vertical muscle of the tongue
   E. Superior longitudinal muscle, inferior longitudinal muscle, hypoglossus muscle, vertical muscle of the tongue

2. Which two muscles can perform the function of the masseter muscle if it is paralyzed?
   A. The medial pterygoid muscle and the temporal muscle
   B. The lateral pterygoid muscle and the temporal muscle
   C. The medial pterygoid muscle and the sternocleidomastoideus muscle
   D. The medial pterygoid muscle and the temporal muscle
   E. The lateral pterygoid muscle and the sternocleidomastoideus muscle

3. Which of the following statements concerning the temporomandibular joint is false?
   A. The coronoid process and the mandibular fossa of the temporal bone form the temporomandibular joint.
   B. The temporomandibular joint is a ‘connected flexible’ bony connection.
   C. The articular disc separates head and pane from each other so that two completely separated articular cavities exist.
   D. The shape of the mandibular condyle fits the socket and shows an ellipsoid shape, which is slightly wider at its lateral aspect.
   E. Due to the type of movement made by the temporomandibular joint, it is referred to as a mixed joint, with four degrees of movement.

References

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Rudolf Schweitzer, Bewegungsapparat, 2. Auflage, Urban & Fischer

Uhlmann, Lehrbuch der Anatomie des Bewegungsapparates, Quelle & Meyer Verlag Wiesbaden

G.H. Schumacher, Funktionelle Morphologie der Kaumuskulatur, VEB Gustav Fischer Verlag Jena
Correct answers: 1B, 2D, 3A

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