This article continues our series on the senses and looks at the sense of taste, or gustation.

Taste provides us with information about the foods and fluids we eat and drink. Like smell, it depends on the detection of chemicals – those present in food are dissolved in saliva, which bathes the taste buds. These detect the tastes and relay the information to the brain where it is interpreted and appreciated.

The brain also receives other information about taste. We know that smell plays an important part in our ability to identify particular tastes, and a blocked nose due to a cold will make food taste bland because its smell cannot be detected.

It is possible that the texture of foods also helps us to recognise them. Identifying particular tastes probably therefore involves several areas of the brain (Allan, 2005).

**TASTE BUDS AND RECEPTORS**

Taste receptors are found in small oval-shaped structures called taste buds, which are mainly on the tongue (Martini, 2005). There are up to 10,000 taste buds (Allan, 2005) in the mouth.

Each taste bud contains up to 40 taste receptor cells or gustatory cells (Fig 1), which are replaced every 10 days (Martini, 2005).

Microscopic hairs called microvilli, on which are found the receptor sites where chemicals attach and stimulate the taste cells, project from the receptors through the tip of the taste bud.

The relatively large taste buds are found in small elevations called papillae, which make the surface of the tongue look rough.

Knob-shaped (fungiform and filiform) papillae are mostly at the tip and the sides of the tongue, and circular (circumvillate) papillae form an inverted V at the back. Each taste bud is attached to two or three nerve fibres, which branch out to form a network that innervate each receptor cell.

**DISTRIBUTION OF TASTE BUDS**

There appears to be a pattern in the way the taste buds respond to different tastes:

- Those that are most sensitive to sour chemicals (typically the taste of acids) are located at the sides of the tongue;
- Detection of sweetness (nutrients rich in energy) is at the front of the tongue;
- Bitterness is sensed in receptors at the back of the tongue;
- Saltiness is detected by all receptors but especially those at the tip of the tongue;
- Umami is a pleasant taste of amino acids, especially glutamate – it is a ‘meaty’ taste of meat broths and strong cheese and its receptors are found in the circular papillae at the back of the tongue;
- Water is often thought to be tasteless but there are water receptors, especially in the pharynx, which affect several systems in the body that deal with water regulation and the balance of our blood volume (Martini, 2005);
- The metallic taste may also be primary (Thibodeau and Patten, 2005).
THE MECHANISM OF TASTE
All the tastes humans experience depend on how the taste receptors are stimulated.

They respond most readily to unpleasant stimuli – we are almost 1,000 times more sensitive to acids, which give a sour taste, than to sweet or salty chemicals, and 100 times more sensitive to bitter compounds than to acids (Martini, 2005).

This is important for protection and survival as acids can damage the mucous membranes of the mouth and pharynx and many powerful biological toxins produce an extremely bitter taste.

Very much weaker concentrations of bitter substances are required to elicit a bitter sensation than the concentrations required for sweet or salt chemicals, while receptor cells for sourness tend to have intermediate thresholds (Allan, 2005).

Temperature also alters taste perception – salt and bitter tastes are much stronger at lower temperatures while sweetness is enhanced at temperatures of around 40°C. Sourness, on the other hand, does not seem to be affected by changes in temperature.

Sensitivity to the primary tastes is also influenced by individual variation, age and temperature. The best-known example of individual sensitivity is to the compound phenylthiourea, which about 30% of Caucasians cannot taste at all.

Ability to taste declines with age. Humans are born with over 10,000 taste buds but this number begins declining dramatically by the age of 50 (Martini, 2005). As the sense of smell also declines with age, the loss of taste is significant. Many older people find their food tastes bland and unappetising, whereas children tend to find the same foods too spicy.

It appears that any single taste bud can respond to several and possibly all of the primary tastes. However, each taste bud is particularly sensitive to one taste type only (Allan, 2005).

GUSTATORY PATHWAYS TO THE BRAIN
Sensory information on the nerve fibres from taste buds travels from the tongue via the three cranial nerves:

- VIIth (facial) cranial nerve carries information from the anterior two-thirds of the tongue;
- IXth (glossopharyngeal) from the posterior third of the tongue;
- Xth (vagus) nerve from the taste buds on the surface of the epiglottis.

Information from all three nerves is relayed to the medulla (Fig 2). From here, nerves pass to the thalamus and then to the gustatory area of the cerebral cortex.

We are consciously aware of taste when information from the taste buds is correlated with other sensory data. Information concerning the general texture of the food, together with taste-related sensations such as ‘peppery’ or ‘burning hot’ is provided by the trigeminal (Vth cranial) nerve.

In addition, the level of stimulation from the olfactory receptors plays a large role in taste perception – sensitivity to taste is 1,000 times greater when the olfactory organs are fully functional. When airborne molecules cannot reach the olfactory receptors because of a cold, meals taste dull and unappealing, even though the taste buds may be responding normally (Martini, 2005).

Relatively little is known about how the brain integrates gustatory information but dysfunctions of the system do occur. Allan (2005) points out that some people with epilepsy report experiencing a distinctive taste in the mouth preceding a seizure. This may be caused by abnormal firing of cells in the gustatory cortex or the neighbouring temporal cortex. Hallucinations of taste can also occur as a result of irritative lesions in part of the limbic area of the cortex (Allan, 2005).

Patients often lose their sense of taste during illness and two factors are important in encouraging them to keep eating – careful attention to oral hygiene and well-presented, appetising food to tempt them to eat.