Understanding nasal disease is important to the ear care clinician for a number of reasons. Firstly nasal disease can affect Eustachian tube function and may be influential in causing ear disease. Secondly it may be necessary to treat both the ear and the nose to get resolution of ear problems and it is certainly worthwhile having normal nasal function before offering surgery to the ear. Lastly, treating the nose can be an end in itself. Sometimes people suffer with nasal symptoms and don’t have ear problems but it is nice to be able to offer them something to ease their suffering.

This tutorial is about the anatomy and physiology of the nose and paranasal sinuses. It will introduce some new words into your vocabulary and it will prepare you for the next tutorial, which is about rhinitis and sinusitis. It starts with a description of the function of the nose and sinuses and then covers the basics of anatomy and physiology. You will need to understand this well before starting the next tutorial.

**OVERVIEW OF THE FUNCTION OF THE NOSE**

The first purpose of the nose is to make the air clean, moist and warm so that it can pass into the lung without causing harm. This is its air-conditioning function and it is very important. Its second function is to allow us to smell our environment, food and to sense danger.

**Air-conditioning**

The lungs require air that is at body temperature, is moist and clean and it is the job of the nose to provide this. It has a very rich blood supply, which is close to the surface of the nose, and this helps with raising the air temperature. The cool air is warmed by blood passing through these vessels. It is the rich blood supply that makes the nose bleed so easily when it is hit, picked or operated upon.

The nose moistens the air in a couple of ways. Firstly the lining of the nose contains mucus glands that secrete slightly sticky mucus onto its surface. Secondly the blood vessels in the lining of the nose squeeze out some of their own plasma contents onto the lining. This combination makes the lining of the nose wet so that when air is drawn into the nose it quickly picks up this moisture and becomes saturated itself. You can see the moisture in your breath if you breathe out onto a cold surface because this moisture condenses as a plume of steam.

The cleaning function of the nose is achieved by the mucociliary clearance system. This system is microscopic in size and works at the surface of the cells that line the nose. Each of these cells has a small tuft of cilia projecting from its surface and these move back and forth and sweep mucus and debris stuck in that mucus backwards towards the back of the nose and then down the throat. The diagram below shows a magnified view of a few cells in the lining of the nose and how their cilia embed in the mucus layer.

The second picture shows a histological slide of the lining of the nose and sinuses. It is called a respiratory epithelium and histologists describe it as pseudostratified,
ciliated, columnar epithelium. These terms need not worry you but it is sometimes nice to know a little about the fine detail of the nasal structure.

In this diagram you can see that the mucus layer is in fact two layers: a gel layer that is sticky and a sol layer which is more fluid.

The cilia stick into the gel layer and move it backwards towards the throat. Any particles of debris attached to the sticky gel move backwards with it.

This slide shows the lining of the nose in magnified detail. The lining is called a respiratory epithelium and you can see the cilia projecting out of the cells at the top.

Note the goblet cell. This produces the mucus that spreads out over the cilia and both traps particles and helps moisturize the air that we breathe in.

The mucociliary system exists throughout the nose, sinuses and lungs and it keeps these clean by removing debris and pushing it down the throat.

When the system breaks down the nose and sinuses quickly become infected because trapped viruses and bacteria aren’t swept away. An infective rhinosinusitis may develop. Cigarette smoke is known to paralyze the cilia and it is related to an increased risk of sinonasal infection. Cocaine does the same thing. Some patients are born with cilia that do not work and they commonly have sinus infections.

Sense of smell.

The second function of the nose is to allow us to smell. This sense is one of the oldest senses and developed at a very early stage of man’s evolution. It alerts us to danger from bad food, fire, smoke and other environmental hazards. It is absolutely essential to the sense of taste and when it is lost food tastes uninteresting.
The organ of smell is called the olfactory organ and it sits high up in the roof of the nose. It sends small nerve bundles through the front of the skull into the olfactory bulb and from here the information passes via the olfactory nerve to the brain.

The diagram shows that the olfactory organ is high in the nose and that there are nerve bundles that pass through the anterior skull base into the olfactory bulb. The bulb is attached to the olfactory nerve (Cranial nerve 1) that passes backwards into the brain.

The olfactory nerve is a special visceral afferent nerve.

Loss of smell commonly happens when the nose itself is blocked when the patient has rhinitis. It also happens after a head injury and if this is severe it may never recover. Sinus infections and brain tumours can also cause loss of smell. A complete loss of the sense of smell is called anosmia.

**ANATOMY OF THE NASAL CAVITY AND SINUSES**

In its simplest form the anatomy consists of a nasal cavity that is divided into two equal parts by a septum. Each half of the nose consists of a floor, a lateral wall and the septum.

It is the lateral nasal wall that is generally the most interesting structure as it contains the turbinates, the ostia of the sinuses and the opening of the naso-lacrimal duct and the Eustachian tube.

The next diagram shows these structures. Note that there are three turbinates on each side of the nose (inferior, middle and superior turbinates) and that the sinuses open into the nose underneath these structures.

The purpose of the turbinate is to increase the surface area of the lining of the nose and this helps in its air conditioning function.

Most sinuses open under the middle turbinate into a space called the middle meatus. This space may be very narrow and easily blocked by small amounts of disease. If this happens the sinuses cannot drain and they become infected. We will cover this in the next tutorial.
The four sinuses are air filled spaces within the bones of the facial skeleton. They are called:

1. Maxillary sinus – inside the maxilla bone under the eyes
2. Frontal sinus – inside the frontal bone above the eyes
3. Ethmoid sinus – lie between the eyes
4. Sphenoid sinus – lies in the centre of the head under the pituitary gland

The diagram below only shows the maxillary sinus (9), the frontal sinus (1) and the ethmoid sinuses (2).

These sinuses open into the nose in a particular way that makes them susceptible to infection. We will see more about this in the next tutorial. For now we will concentrate on physiology and anatomy.

The sinuses are filled with air when they are healthy. They are lined by respiratory epithelium just like the nose and lungs and they communicate with the nose via small ostia (holes). These ostia are no more than a few millimeters in diameter.

The purpose of the sinuses is not really known although there are a lot of theories. The current theory is that they are the sites of nitric oxide gas production that is beneficial to the lung when it is breathed in. Alternative theories suggest that they lighten the facial skeleton, offer resonance to the voice or that they aid in buoyancy.

The darker area in the center is the nasal cavities divided by a midline nasal septum.

On either side you can see sinuses shaded in grey and the two largest (9, the maxillary antra) are seen opening into the nose via the small white arrows.

The frontal sinus (1) and the ethmoid sinuses (2) are also shown.

From Logan Turner, Diseases of the Throat Nose and Ear.

The diagram demonstrates a few other interesting things. Note how close the eyes are to the ethmoid sinuses. It is easy for disease in the ethmoid to spread to the eye and cause blindness. Cancers and infections can do this. Just above the frontal sinus
lies the brain. This is also very close by and infection from the sinuses may cause meningitis and brain abscesses.

Note also that the teeth are close to the maxillary sinus. In some people the roots of the teeth are actually inside the sinus. When these teeth get infected the sinuses can suffer as well.

These close anatomical arrangements and the ease with which disease spreads from one area to another means that examination of the sinuses must include examination of the teeth, eyes and brain.

MORE PHYSIOLOGY OF THE NOSE AND SINUSES

We have learned a little about the air conditioning function of the nose. Now we need to know a little more detail about mucociliary clearance. This system is responsible for cleaning the nose and the sinuses and it happens in a predictable and constant way in health.

In the nose all of the cilia projecting from the surface of the epithelium of the nose beat towards the nasopharynx. This means that all mucus (with its trapped particles and bacteria etc) is moved backwards in a continuous stream towards the back of the nose and then down the throat where it is swallowed. We make about half a liter of mucus every day.

In the sinuses all of the cilia beat towards the ostium (plural is ostia) of the sinus and this means that any debris, bacteria of dirt that finds its way into the sinus is swept out of the sinus and into the nose. Once in the nose it is picked up by the cilia in the nose and swept backwards.

The sinuses do not drain by gravity. Mucus doesn’t fall out of them it is swept out. Have a look back at the previous diagram. The ostium of the maxillary sinus is high up on the medial wall of the sinus (white arrow). Gravity can’t move the mucus made in the sinus out of the ostium. Instead the mucus must be swept there by cilia. The next diagram shows the patterns by which mucus is swept from the maxillary and frontal sinuses.
Cilia in the maxilla beat mucus against gravity upwards to the highest point on the medial wall. It then passes out of the sinus through the ostium.

Note that the diagram shows a second ostium. This is called the accessory ostium of the maxillary sinus. It has no drainage function.

The Frontal sinus has an ostium at its inferior most point but it still does not use gravity to clear its mucus.

The cilia beat the mucus in a circular fashion around the sinus and then out into the nose.

http://www.gla.ac.uk/ibls/US/cal/anatomy/paranasal/mucociliaryclearance.html

Blockage of the ostium or paralysis of the cilia leads to stasis. Stasis means that there is no drainage and mucus simply collects in the sinus and then gets infected and pus forms. We will see reasons why stasis may occur in the next tutorial.

**Learning points**

1. The nose is an air conditioner. It heats, cleans and adds moisture to the air.
2. Its anatomy and function are related – a large blood supply for heating, mucus for adding moisture, and a mucociliary clearance system for cleaning the nose.
3. It has a large surface area caused by folds in its lateral wall called turbinates.
4. The sinuses open into the nose through small ostia that may become blocked.
5. Blockage leads to stasis of secretions.
6. Disease from the sinuses may spread to nearby structures such as the eye and brain.