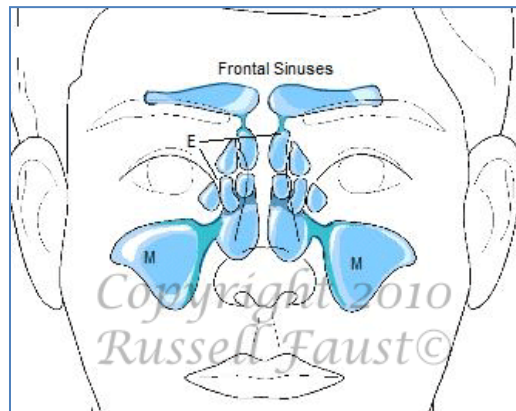


# Nasal and Sinus Anatomy (and histology)

by Russell A. Faust, PhD, MD, FAAP (aka the boogor doctor)

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## Nasal and Sinus Anatomy:

**The first warning:** I am a **Pediatric** Ear, Nose & Throat surgeon – a pediatric boogor doctor – so my perspective in all of my essays is from the perspective of children, and children’s health. Despite that limitation, a lot of the following also pertains to adult anatomy and histology. The goal of this article is to familiarize you with some of the complexity of how the nose and nasal sinuses work. In order to understand how they become diseased, and how to get them and **keep them healthy**, we need to understand the underlying anatomy – how they are put together and how they function.

That leads me to **the second warning:** this is a relatively long and detailed article. My apologies, but if you have found this article in your searches, I suspect that you have a child who is very ill with chronic sinusitis, perhaps also with asthma, and you are motivated to get them healthy. So perhaps you will tolerate the length and detail of this article.

Caring for a child with chronic rhino–sinusitis can be frustrating for everyone – for the child, for the parents, and for the physicians who are tasked with making them better. I will do my best to help.

I think that understanding nasal and sinus anatomy and function will be a good start. Some of the resources listed at the end of this article can guide you to your next step.

From here, I urge you to take a look at a couple posts (articles) on my blog, boogor doctor.com. Links to these articles are listed at the end of this article under **Resources**.

With that out of the way, let’s get to it ...

The anatomy and physiology of the nose and sinuses is complex, suitable to the complex functions that these organs perform. Aside from looking beautiful, your child's nose (and sinuses) acts as air-conditioner, warming or cooling incoming air, and moisturizing it for the lungs. They also provide the first line of immune defense against airborne microorganisms and pollutants. The complexity of this job is really appreciated only when we look at the lining of the nose and sinuses on the cellular level. Considering the world that we live in, and the air we breathe in, this is a huge task.

## **ANATOMY:**

**External Nose:** the external nose – the part of the nose that you see – is there for more than just great looks. Those cartilage and bone structures are there to keep the nasal airway propped open. Think of the boxer with the pulverized nose who can no longer breathe through his nose. Anyone who has ever broken their nose – elbow during basketball, softball to the nose, etc. – knows that having those structures intact helps keep your nose open, helps keep your breathing open and smooth.

**Nasal Cavities:** where the action takes place:

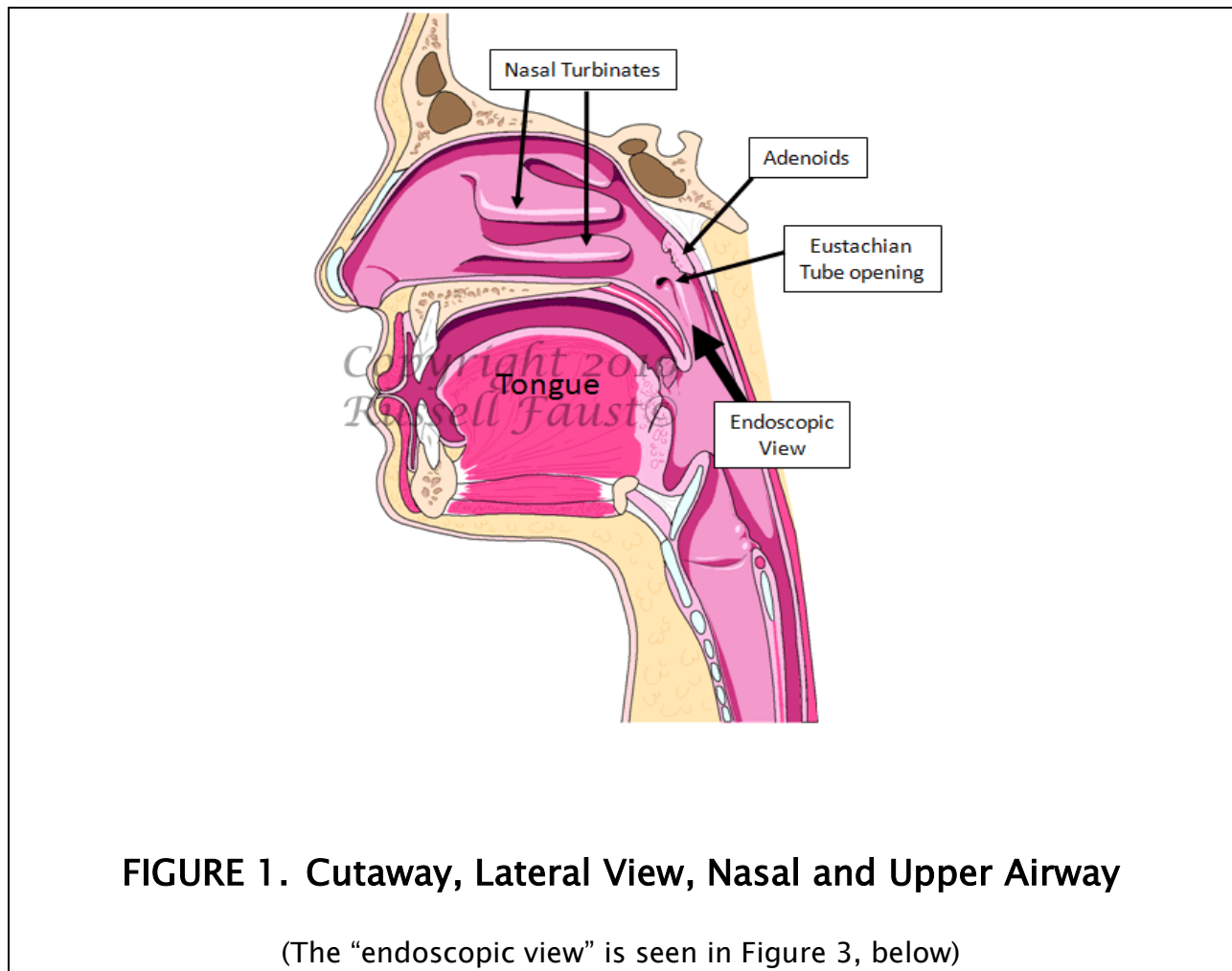
- air conditioning – humidification, warming, or cooling incoming airstream
- filtering incoming airstream of microorganisms and pollutants
- immune function – preventing infection by airborne microorganisms
- olfaction – sense of smell
- affects voice quality – voice resonance

**Nasal Septum:** divides the nose into right and left halves, helps support the “dome” of the external nose. If the nasal septum is deviated (born like that or acquired from trauma), obstruction may result. If severe enough, septal deviation can warrant surgery (septoplasty) to improve nasal airway.

**Turbinates:** 3 swellings along the outside wall of the nasal cavity. Their function:

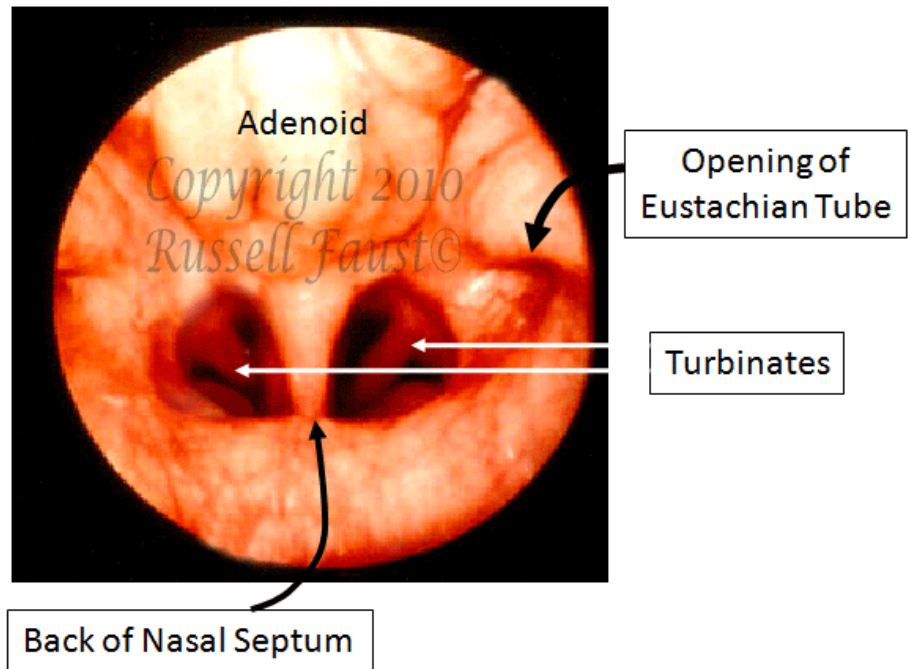
- create turbulent airflow – this aides in olfaction, and helps mucus trap microorganisms and pollutants in the airstream
- cover the openings to the paranasal sinuses
- alter voice resonance ? just speculating here

**Adenoids:** this is a “blob” of lymphoid tissue, a bit like tonsil tissue, at the very back of the nose. The **upside:** Adenoids play a key role in our immune reactions to foreign materials in the air we breathe in. The **downside:** Recent studies suggest that the adenoids often act as a possible **reservoir for bacteria** that cause chronic sinusitis and ear infections (otitis).



**FIGURE 1. Cutaway, Lateral View, Nasal and Upper Airway**

(The “endoscopic view” is seen in Figure 3, below)



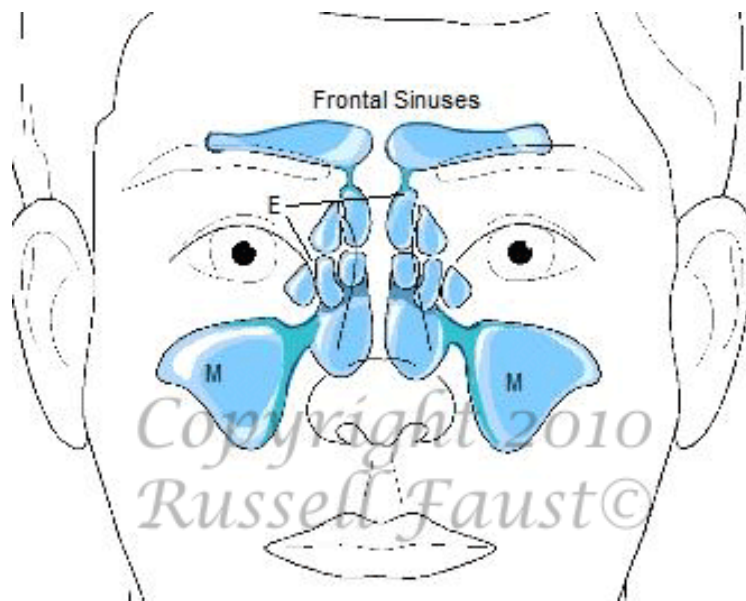
**FIGURE 2. View of Adenoids and Back of Nose**

(“endoscopic view” on Figure 1)

From this endoscopic view, it is easy to see how the adenoids could block nasal breathing if they become swollen. Even without blocking the nose, if the adenoids become chronically infected they can act as a reservoir for bacteria. This would provide the “seed” for re-infecting the nose and sinuses, or re-infecting the ears in cases of chronic and recurrent otitis. Several studies now suggest that this does happen in people (adults and children) who have chronic and recurrent rhinosinusitis, or otitis.

**Paranasal Sinuses:** (refer to Figure 2, below) air-filled cavities within the bones of the face, connected to the nasal cavities. There is great variation in sinus shape and size between people. They have uncertain role; some speculate that they help lighten the facial skeleton. The sinuses consist of four paired cavities, each of which is named after the bone in which it is located. They consist of:

- **Maxillary** sinuses – in bones of cheeks, one on each side. May grow to be as large as 15ml (could hold about 3 tablespoons).
- **Ethmoid** sinuses – usually 6 – 10 per side, situated between the orbits (eye sockets), up to the skull base. Responsible for more complications from sinusitis than other sinuses, usually involving the orbits (eye sockets) and tissues around the eyes.
- **Sphenoid** sinus – 1 or 2 lie in the very middle of the head, surrounded by the pituitary, optic nerves, internal carotid arteries – all important structures. Rarely a source of sinusitis complications, but due to location, complications can be life-threatening (meningitis, brain abscess), and surgical treatment can be challenging or risky.
- The **frontal** sinuses – situated in the eyebrow area of forehead bone of the skull. Usually one each side, but one or both are absent in about 5% of us. Due to the fact that the brain is just behind the frontal bones, sinusitis complications in the frontal sinuses can be serious (meningitis, brain abscess); fortunately this is rare, especially in children.



**FIGURE 2. The Pediatric Sinuses:**

**E** shows where the *ethmoid sinuses* are, in the bones between eyes, next to the nasal passages.

**M** shows where the *maxillary sinuses* are, in the bones of the face, behind the cheeks.

The *frontal sinuses* lie in the bones of the forehead.

The *sphenoid sinuses* are not seen in this figure.

The openings to the maxillary sinuses lie above the sinus, meaning that the secretions need to flow **uphill, against gravity**, in order to get out of the sinuses.

The openings for the ethmoid sinuses are multiple, and tiny. **ANY** swelling from inflammation (allergies, exposure to tobacco smoke, viral infection, etc.) can result in obstruction of the openings ... leading to sinusitis.

## HISTOLOGY:

(See Figure 4, below)

The lining of the nose is our first line of defense against airborne microorganisms and pollutants. This task is handled by the **epithelium** by the mechanism of **mucociliary clearance** (more about this in the article, “Ciliopathies,” and on my blog).

**The nasal epithelium functions to:**

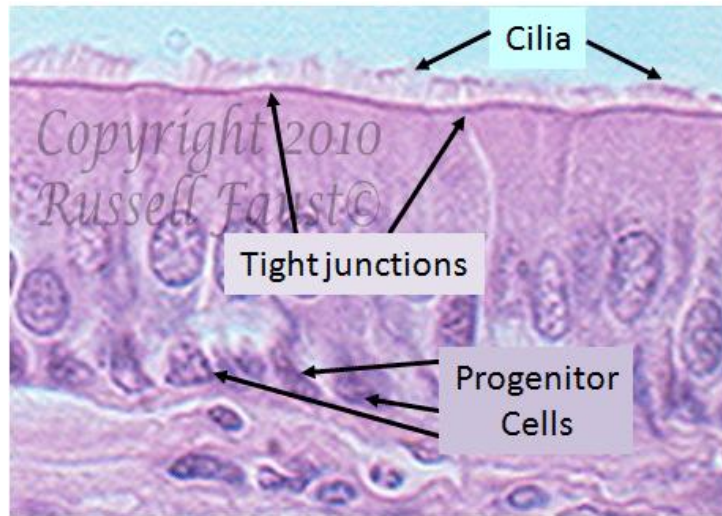
- Acts as a physical barrier to inhaled foreign materials
- Entraps and clears foreign material by ...
- **Mucus** secretion (snot) and
- **Cilia** activity
- Is an active part of our **immune** response – contains enzymes and antibodies
- Helps condition the air we breathe in: warm it, cool it, moisturize it

**Nasal epithelium** is comprised of

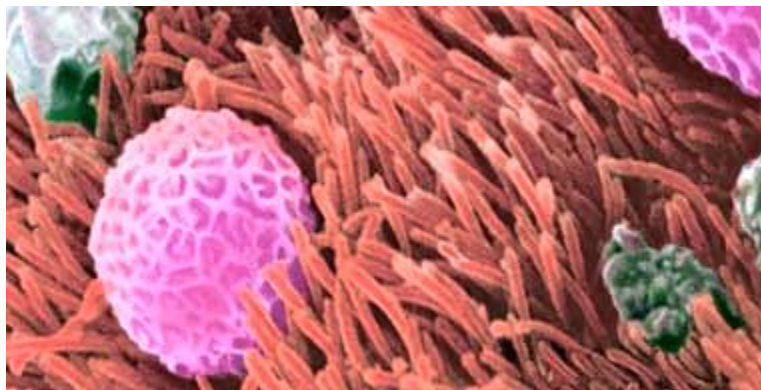
- cells with cilia
- cells without cilia
- **goblet cells** (they make the snot), and
- **basal cells** (“baby” cells, progenitors or stem cells)
- transient immune cells – **lymphocytes** and **mast cells**

The ciliated and non-ciliated cells help create most of the physical barrier as they form a tightly-connected sheet that lines the nasal cavity. All these cells form a “**tight junction**” between themselves, effectively keeping foreign materials – **pollutants and microorganisms** – from getting into our tissues and bloodstreams. A breakdown in this barrier can be dangerous.





**FIGURE 4. Histology: Respiratory Epithelium**



**Figure 5. Looking down on Nasal / Sinus Cilia**

Scanning Electron microscopy of nasal cilia (orange in this image).

The pink ball is a speck of pollen. The gray blobs are dust particles.

(Image copyright California Agriculture, from article <http://bit.ly/8ZXGT8>, and displayed here with permission)

## The Function of Snot and Cilia:

(see Figure 5, above)

- The goblet cells produce mucus. Nasal mucus (aka snot), in the proper viscosity (thickness, stickiness) and in the proper amount, is necessary for the mechanism of *mucociliary clearance* to work normally. Microorganisms and particulate pollutants (like dust or pollen) in the airstream stick to the mucus – sort of a microscopic fly-paper.
- Cilia of the ciliated epithelial cells work in coordination to sweep out the mucus that contains any adherent foreign material, including microorganisms and pollutants. In order to work normally, these cilia need a certain level of humidity. They are also VERY sensitive to airborne pollutants. These include toxins that are in cigarette smoke, and various volatile organic compounds (VOC's). VOC's are all around us in our man-made world. They come out of our cleaning agents, out of adhesives, and out of most plastics. If *mucociliary clearance* does not function, life-threatening infections can result.
- The immune response of the nasal epithelium helps us fight off attacks from various microorganisms (viruses, bacteria, mold), but if it goes haywire, can contribute to *allergic rhinitis*. Finally, the mucus contains special **antibodies** and **enzymes** that:
  1. prevent viruses and bacteria from sticking to the epithelial lining
  2. help our white blood cells to recognize viruses and bacteria as invaders and to kill them

The basal cells are progenitor cells – baby cells – that will divide and grow to replace the other cell types when they grow old or are lost due to a toxic environment.

You now understand more about nasal and sinus anatomy than some medical students. Armed with this knowledge you should consider looking at some articles on complications of sinusitis, and some articles on curing sinusitis. There are some simple general principles, some simple steps that you can take to control your child's sinusitis. Success in this will help control their asthma, their ear infections, and other chronic upper airway illnesses. Check the resources for how ... no ads, no spam, not selling anything. Just trying to empower with information: **Stay Informed. Stay Healthy.**

## Resources:

**The Ciliopathies** (<http://wp.me/pR4iB-ch>), from my blog. The article can be downloaded from scribd.com as a free pdf file at this link: <http://scr.bi/c9fiFb>.

**8 Principles for Controlling Your Child's Sinusitis** (<http://wp.me/pR4iB-91>), from my blog. The article can be downloaded from scribd.com as a free pdf file at this link: <http://scr.bi/aL3CPw>.

**8 Dangerous Complications of Sinusitis, But 3 That Can Kill** (<http://wp.me/pR4iB-57>), from my blog. With your new understanding of sinus anatomy you will get more out of this article.

**Stop Breathing, Your Air is Killing You (and what to do about it)** (<http://wp.me/pR4iB-5E>) on my blog. The article, **8 Ways to Clean Your Air**, can be downloaded from scribd.com as a free pdf file at this link: <http://scr.bi/clck0B>.

Also check out the 4-part series on using **Nasal Saline Rinses to Cure Sinusitis**, <http://wp.me/pR4iB-1Y>, and the article on using **Honey – Nature's Antibiotic**, available on scribd.com as a free pdf: <http://scr.bi/aUkFfx>.

Check my blog, <http://www.boogordocor.com> for more.

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