

- o Ossified in the membrane covering its postero-inferior part.
- o 2 ossification centers, one on either side of the middle line, appear about the 8th wk of fetal life hence the vomer consists primarily of two lamellæ.
- o About the 3rd month these unite below, and thus a deep groove is formed in which the cartilage is lodged.
- o As growth proceeds, the union of the lamellæ extends upward and forward, and at the same time the intervening plate of cartilage undergoes absorption.
- o By the onset of puberty the lamellæ are almost completely united to form a median plate, but evidence of the bilaminar origin of the bone is seen in the everted alæ of its upper border and the groove on its anterior margin.

Note: Perpendicular plate **endochondrial** ossification Vs **vomer** is **membranous** ossification

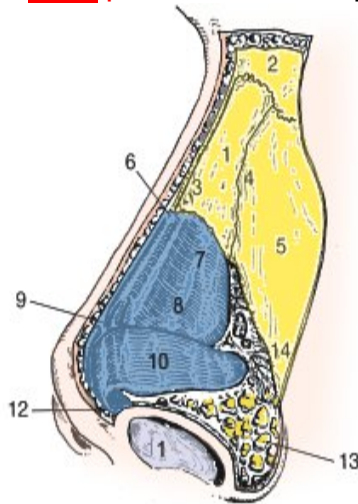
External features of the nose

Anatomy of the Nose

Note: over the dorsum and sides of the nose the skin is thin and loosely adherent where it becomes thicker and more adherent over the tip and alar cartilages.

The external nose is composed of two parts:

1- Upper bony part which is composed of :



Nasal bones which is articulate together in the middle line. 1

Nasal process of frontal bone 2.

Nasal process of maxillary bone 5.

Lateral osteotomy is created in the ascending part of the maxilla

2- Lower cartilagenous part which is composed of: (hyaline cartilage which may be ossified)

Upper lateral cartilage 7+8.

Major alar cartilage (lower lateral cartilage) 10.

Minor alar cartilage at ala nasi 13.

1-4 minor sesamoid cartilages are found between upper and lower lateral cartilages.

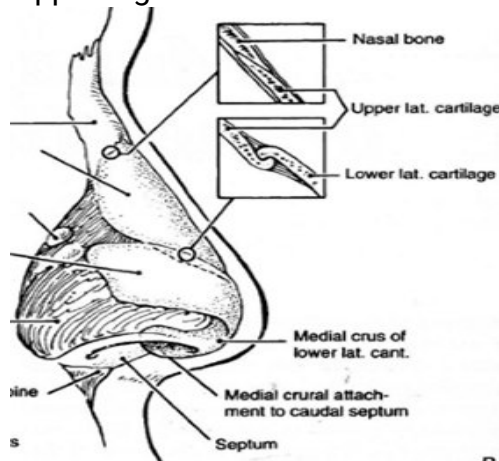
Limem Nasi: the groove between the upper and lower lateral cartilages (caudal margin of the upper lateral cartilage); which is the site of intercartilagenous incision

Sallion: Deepest part in the nasofrontal angle

Nasion: The anatomical midpoint of the nasofrontal suture

Supporting system:

Major supporting area:

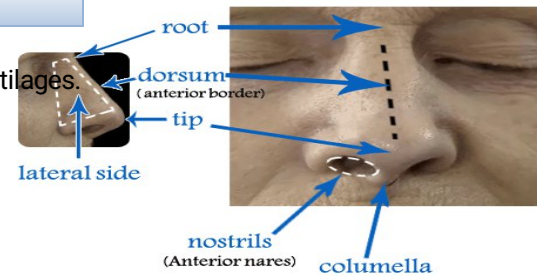


Key stone area (rhinon/osteocartilagenous junction): 6

The area where the upper lateral cartilage is attached to the undersurface of the nasal bone

This area should be preserved in rhinoplasty

Scroll area:



Where the superior lateral cartilage is attached to the undersurface of the inferior lateral cartilage

So the relation is interlocked scroll

Where the median crura of the lower lateral cartilages attached to the nasal septum

N.B: Major alar cartilage is composed of 2 crura lateral and medial.

The two medial crura form "columella".

So the columella is not part of the septum

The intermediate crus of the alar cartilage: represents the transitional segment between the lateral & medial crus

Nasal tip support:

Major support structures:

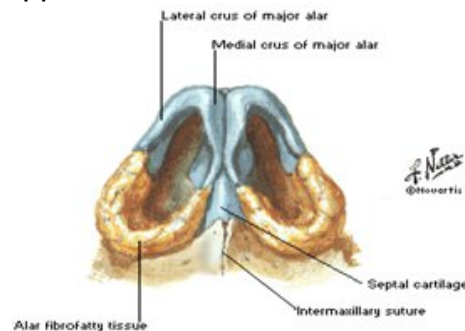
Attachment of the upper lateral cartilage to the lower lateral cartilage

The size & shape of the alar cartilage (lower lateral cartilage)

Medial crural foot plate attached to the caudal septum

Nasal spine

Minor support structures:



Interdomal soft tissue

Cartilaginous dorsum

Soft tissue-sesamoid complex attaching the lateral crus to the piriform wall

Alar cartilage attaching to the skin & soft tissue

Membranous nasal septum

Cottle's classification:

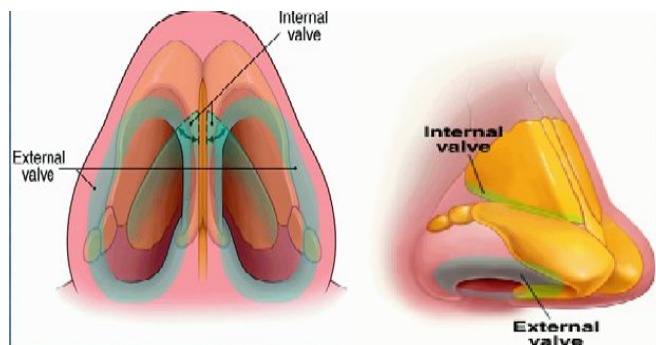
Area 1: Anterior caudal area

Area 2: Nasal valve area

Area 3: Superior mid area

Area 4: inferior mid area

Area 5: posterior choana area



Pyriform aperture:

The **anterior** most and **narrowest** area of the bony part of nose

Boundaries of pyriform aperture:

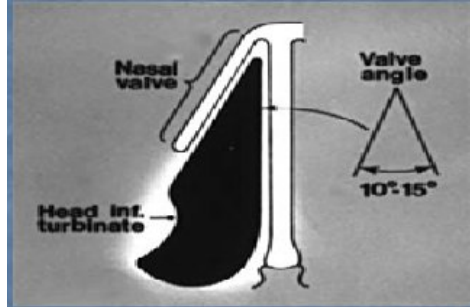
Superior: Nasal bone

Lateral : **nasal** process of maxilla

Inferior: **Alveolar** process of the maxilla

Anterior nasal spine:

lies in the **middle** Of **inferior** border of the pyriform aperture



Made by the junction of the **alveolar** processes at the midline

It can be up to **15mm** in length

Nasal Valve:

It is divided into:

1. External Nasal valve
 2. Internal Nasal Valve
- 1) External nasal valve (nasal vestibule) formed by:
- columella
 - Nasal rim (caudal border of the lower lateral cartilage).
 - nasal floor
- The nasalis muscle dilates this portion during inspiration. (So if denervated will lead to alar collapse even in quiet respiration).
- 1) Internal nasal valve formed by:
- Nasal septum
 - caudal border of the Upper lateral Cartilage
 - head of the inferior turbinate
 - pyriform aperture and the tissues that surround it.

Three components of nasal resistance:

- A. Nasal vestibule (external nasal valve): Collapses on inspiration
- B. Nasal valve (internal nasal valve): Narrowest point, Normal angle is 10° to 15°
- C. Nasal cavum: Located posterior to pyriform aperture, Minor component of resistance

Note: the nose is responsible for 50% of the total airway resistance. During expiration the positive pressure is transmitted to the alveoli. Removal of this resistance by tracheostomy reduces the dead space but results in a degree of alveolar collapse. Reduced alveolar ventilation gives a degree of right-left shunting.

Nasal Valve angle: angle between the caudal end of the upper lateral cartilage & nasal septum

It is located at the **posterior end** of the vestibule at **transition** between the skin and respiratory epithelium, **1.3cm** from the **Nares**.

The average valve area changes from **90 mm²** to a thin passage of **30 mm²** during normal respirations, the **extrinsic** and **intrinsic** muscles can change these relationships

This area is the **narrowest** part of the nose

Responsible for more than **2/3** of the **resistance** (producing a **major flow** resistant segment in the **nose**).

Air passing through this segment is moving at the **fastest** speed

The **anterior** tip of the **inferior** turbinates has the greatest influence on the nasal flow among the turbinates

1. Every **rhinoplasty** surgeon should know that excessive excision of the upper and lower lateral cartilages may cause valve collapse and depress nasal respiration.
2. **Air starved patient**, such as the asthmatic or chronic bronchitic, will frequently have nasal flaring in an attempt to minimize the effect of this area on total airflow.
3. **Breathe-Right device**, which is a small adhesive band with two parallel plastic strips applied across the middle third of the nasal dorsum, increase the cross-sectional area at the nasal valve by **21%**, and resulted in a **27%** decrease in nasal airway resistance.

Nasal obstruction symptoms occurs when **total nasal resistance** is greater than **3.0 cm H₂O/L/SEC**

The **greatest linear** velocities and **differential pressures** in the upper airways are found in the nasal valve space.

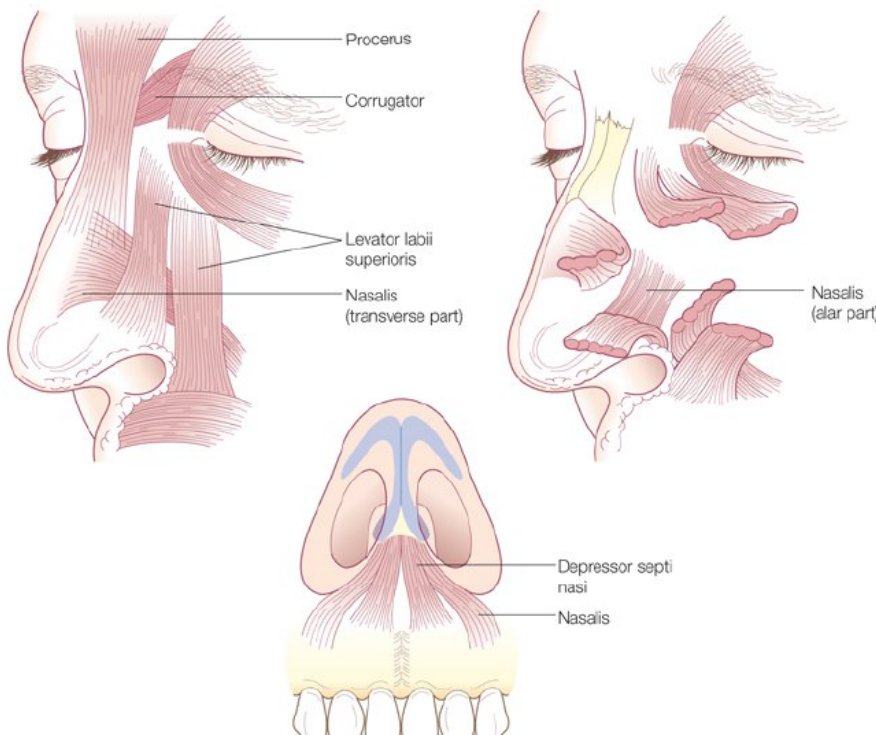
Once air passes through the nasal valve, the cross-sectional area greatly increases, and the velocity falls

rapidly.

The **significant decrease** in velocity coupled with the viscous retardation of air by the large surface area gives rise to **turbulent** flow.

There is a **small** amount of turbulent flow to the **roof** of the nose, which probably explains the physiology of the sniff and the route for smells to be perceived by the olfactory receptors at the roof of the nasal cavity.

The back of the nose connects with the nasopharynx, where the two passages combine into one where the normally **turbulent** airflow of the nose is transformed into a **linear** flow pattern.



External muscles of the nose:

- Depressor septi nasi: depresses septum and tip
- **Nasalis** (alar and transverse parts): contracts/**dilates** nasal aperture
- **Procerus** (depressor glabellae): shorten (**elevate**) nose and depress glabella
- Levator labii superioris

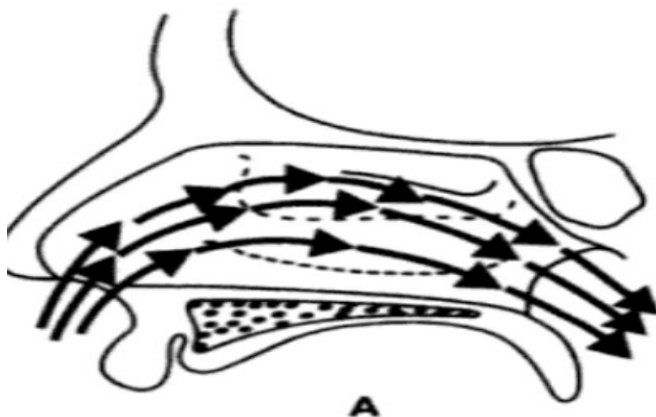
Major functions of the Nose

1. Olfaction

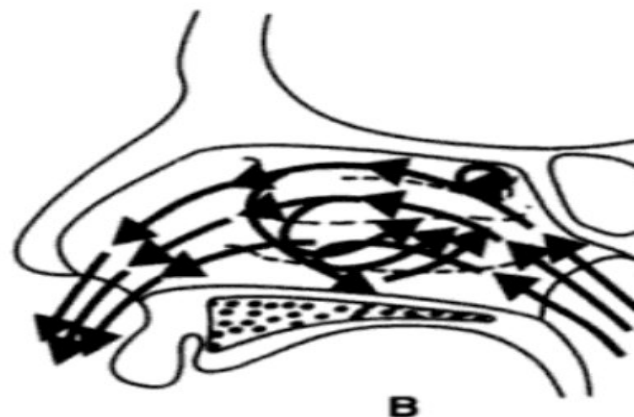
2. Respiration:

air conditioning unit :

- o Warming of inspired air:
thermoreceptors are **limited** to nasal vestibule
warming of inspired air up to **37** degree (10% of human body heat loss occurs through the nose)
Averagely the posterior nasal space air is 31 degrees and is 95% saturated.
This moisture comes from the **water content** of the mucus that is directly transudated from **nasal blood vessels** and supplied by **nasal glands**.
- o humidification of the inspired air
Humidification is reduced by atropine acting on glands rather than the vasculature.



A



B

Regulate respiratory airflow by providing variable resistance to airflow

1. Protection:

Particles in inspired air:

Larger than 3 micrometer has a maximum deposition in the anterior part of the nose, at the

nasal valve area .

3-0.5 micrometer are filtered by the nasal mucosa and transported by cilia propulsion to the **nasopharynx**.

The filtration of particles **smaller than 0.5 micrometer** is low; these particles seem to pass easily into the **lower airway**.

Note: Nose also adds Voice escape quality: if little escapes rhinolalia clausa; if too much escapes rhinolalia aperta (seen in cleft patients)

Note: sinuses have no effect on voice modification.

The nasal airflow:

During inspiration:

Air flow mainly passes through the middle part of the nasal cavity in a parabolic curve :

- 1) **Mainly**: Middle **meatus** & Olfactory cleft close to the medial surface of the middle turbinate
 - 2) Lesser extent: above the middle turbinate the superior meatus & sphenoethmoidal recess
- No** air passes through the **inferior meatus** as Air tends to hit the **anterior** portion of the **inferior** and **middle** turbinates and is directed posteriorly between them.

Little air passes through the **Olfactory area** hence it requires one to sniff up for air current to reach the olfactory area to appreciate smell

The **medial** wall airflow pattern is **along the floor** or **adjacent to the medial turbinates**.

Velocity at the anterior valve is 12-18m/sec during quiet respiration

During expiration:

Air currents follow the same path (but longer duration and is more turbulent)

But forms **eddies** at the anterior end of the middle turbinate + limen nasi

Thus aerates the **middle meatus** + **paranasal sinuses**

Note: Turbulence is central to the nasal physiology & **increases contact** between **inspired** air and the nasal mucosa enhancing **not** only the **respiratory** functions but also **olfaction** and **protection**

Septal deflections may **significantly** change these relationships.

Air tends to hit the **anterior** portion of the **inferior** and **middle** turbinates and is directed posteriorly between them.

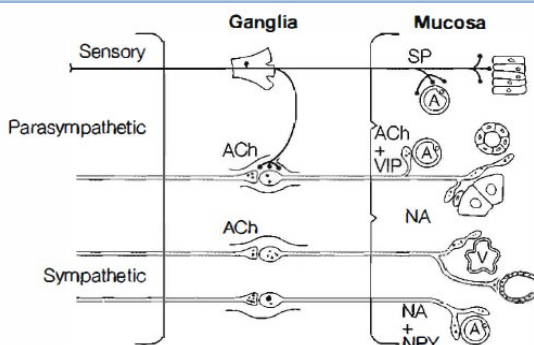


Figure 106.9 The autonomic nerve supply of the nose is mediated by substance P (SP), acetylcholine (ACh), vasoactive intestinal polypeptide (VIP), noradrenaline (NA) and neuropeptide Y (NPY). See text for details.

Factors affecting nasal flow:

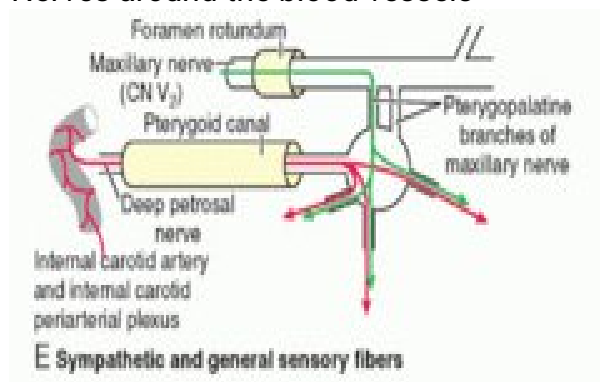
1. Autonomic regulation of nasal vasculature:

The vascular system of the mucosa is under constant sympathetic tone, when this tone decreases the vessels will get engorged

Sympathetic (originate from hypothalamus transmitted via the lateral horn of grey matter of the spinal cord at the level of the 1st and 2nd thoracic vertebrae; preganglionic axons relay/synapse in the superior cervical ganglion; **postganglionic sympathetic fibers form a plexus around internal carotid artery hitching along the carotid from which deep petrosal nerve arises that joins the preganglionic parasympathetic fibers of greater superficial petrosal nerve to form the nerve to pterygoid canal (vidian nerve)**; These postganglionic sympathetic vasomotor fibers pass through the sphenopalatine ganglion (**without relaying**) to the nasal cavity, vasoconstrictor stimulation exerts the major control over venous sinusoid filling by decreasing the volume of blood held in the mucosa causing decongestion of nasal vessels (decongestion of nasal cavity).

It enters the **nose** by at least 4 routes:

Nerves around the blood vessels



Vidian nerve

Maxillary nerve Nasolacrimal nerve

TABLE 39-1 PHARMACOLOGY OF ENDOGENOUS SUBSTANCES ON NASAL MUCOSA

Vasodilators	Vasoconstrictors
Histamine	Adrenaline
Vasoactive intestinal peptide	Noradrenaline
Substance P	
Prostaglandin E ₂	
Bradykinin	

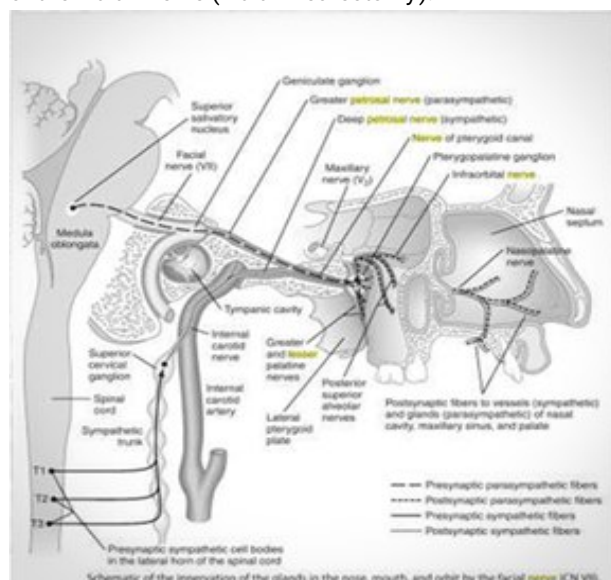
Noradenaline is the main postsynaptic transmitter with Ach acting at the postganglionic synapses.

Cocaine blocks uptake of noradrenaline into the nerve endings.

Local anesthetics: Cocaine is both a local anaesthetic and a powerful vasoconstrictor.

Lignocaine dilates the precapillary sphincters and so a vasoconstrictor is often combined with it. Both groups at high concentrations have systemic effects on the heart and CNS.

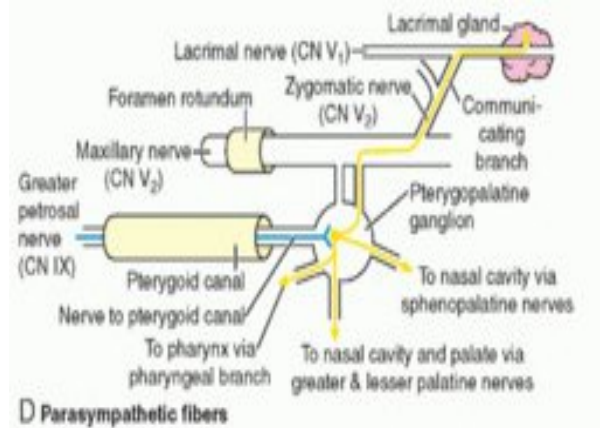
Note: Some surgeons are of opinion that excessive rhinorrhea (vasomotor and allergic rhinitis) can be controlled by section of the vidian nerve (vidian neurectomy).



Parasympathetic (superior secretory nucleus in pons / medulla oblongata proceed via the intermediate branch (nervus intermedius) of the facial nerve to the geniculate ganglion continuing along the greater superficial petrosal nerve, joins deep petrosal nerve forming nerve of the pterygoid canal (vidian nerve) which reaches to the sphenopalatine ganglion where only parasympathetic fibers relay/synapse, postganglionic fibers then pass through sphenopalatine foramen and supply the nasal mucosa. vasodilator fibers exert only minor control of nasal blood volume but cause more potent control of nasal secretions by stimulating a watery discharge.

Distributed along the **maxillary** division branches

At higher rates VIP causes atropine resistant vasodilation. Ach suppresses VIP release by negative feedback.



Pilocarpine and carbachol cause nasal congestion, vasodilation and watery secretions -blocked by atropine-
Histamine may cause vasodilation (In nasal mucosa receptors: H1 predominant, H2 present, H3 absent)

High-dose estrogen contraceptives are associated with rhinitis

Summary:

sympathetic innervation controls nasal airflow

parasympathetic innervation controls nasal secretions (via muscarinic receptors M1, M3)

Co2 = decongestion

Note that **terminal nasal trigeminal** efferent carries:

- o **All parasympathetic** nasal innervations
- o **Some of the sympathetic** nasal innervations

1. **Postural change/reflex**: alter nasal airflow through changes in relative venous pressure (Supine position/laying in lateral position congestion)
2. **Exercise**: results in epinephrine release causing nasal decongestion.
3. **Sex** hormones influence nasal airflow; thus, pregnancy, puberty, and menstruation can increase nasal obstruction
4. nasal cycle

Refers to **spontaneous** congestion and decongestion alternating between the two nasal passages.

The changes are produced by vascular activity, particularly the volume of blood on the venous sinusoids (capacitance vessels).

Cyclical changes occur between 4-12 hours; they are **constant** for each person.

This cycle occurs in approximately **80%** of the population

The nasal cycle results in airway resistance and nasal width changes that affect **airflow turbulence**.

In the **decongested** nasal passage:

1. airway resistance is decreased
2. increasing the nasal width
3. Causing turbulent airflow at **lower** flow velocities.

Although the resistance and airflow alternates between the two nasal cavities, the nasal cycle does **not** significantly change the **combined** nasal resistance and total airflow.

During the cycle secretions are lower in the more obstructed side

Factors affect the nasal cycle: Allergy; Infection; Exercise; Hormones (Pregnancy, puberty), fear

and emotions (including sexual activity); CO₂ in the inspired air produced by rebreathing may also reduce the nasal resistance; The autonomic nervous system controls the changes:

- a. **Vagal overactivity** may cause nasal congestion
- b. Drugs, which block the action of **noradrenaline**, cause nasal congestion.
- c. The **anticholinergic** effects of **antihistamines** can block the parasympathetic activity and produce an increase of sympathetic tone, hence an improved airway.

Studies suggest that the **sensation** of nasal patency may be related to the **temperature** of the nasal passages.

Inspired air cools the nasal lining on inspiration, and this may be detected by thermoreceptors in the mucosa.

Cold receptors sense airflow, and can be stimulated by menthol giving rise to an apparent increase in airflow.

sensation of nasal airflow is:

decreased by the injection of L.A

enhanced by the respiration of cooler air

REFLEXES FROM NASAL STIMULI

Chemical irritation, temperature change and physical stimuli may cause widespread cardiovascular and respiratory responses. Ranges from sneezing to cardiorespiratory arrest. Sensory stimulation can result in intense vasoconstriction of skin, muscles and visceral arteries. It is accompanied by lowered cardiac output. This is a modification of the submersion reflex, which diverts blood away from skin to the brain. When patients have an endotracheal tube passed through the nose, it may give rise to an unexplained bradycardia.

Hot or cold temperature reflex

sneezing upon sudden exposure of skin to dramatic temperature extremes

NASOPULMONARY REFLEXES

Increasing airflow through one side of the nose is associated with increased ventilation of the homolateral lung. Blowing air through the nose causes the bronchiole muscle to relax on the same side and increase respiratory activity.

REFLEXES ACTING ON THE NOSE

Nasal vasoconstriction occurs with increased arterial CO₂, and is mediated by chemoreceptors. Hypoxia has the same effect. Hyperventilation will cause nasal congestion.

CUTANEOUS STIMULATION

Heating the skin of the feet, arm or neck will produce an increase in nasal resistance. Cooling results in vasoconstriction.

Pressure to the axilla (Eccles' reflex) or lying on the dependent side will cause nasal blockage.

CENTRAL CONTROL

The hypothalamus controls cardiorespiratory responses. Stimulation causes marked nasal vasoconstriction.

Vagal overactivity causes prolonged congestion and nasal obstruction in some patients.

Nasal mucosa:

Respiratory epithelium: 20-30 nm

1. **Keratinized squamous epithelium:**

Located in the Nasal vestibule

Contain hair, **sweat** gland, sebaceous gland

1. **Squamous + transitional cell epithelium:**

Located in the **anterior 1/3** of the nasal cavity + **anterior** part of the inferior & middle turbinate

1. **Pseudostratified columnar epithelium (respiratory epithelium) :**

Located in the **posterior 2/3** of the nasal cavity

Olfactory epithelium:

Cell types: Bipolar receptor, Sustentacular, Microvillar, Horizontal basal, Globose basal cells

Located in upper 1/3 of nasal cavity in the posteriodorsal recess (inferior surface of the cribriform fossa) + **superior** part of the nasal septum(10mm) & **superiomedial** part of superior turbinate

60-70 nm; lacks dynein arms

Covers an area of **5 cm² yellowish in color**

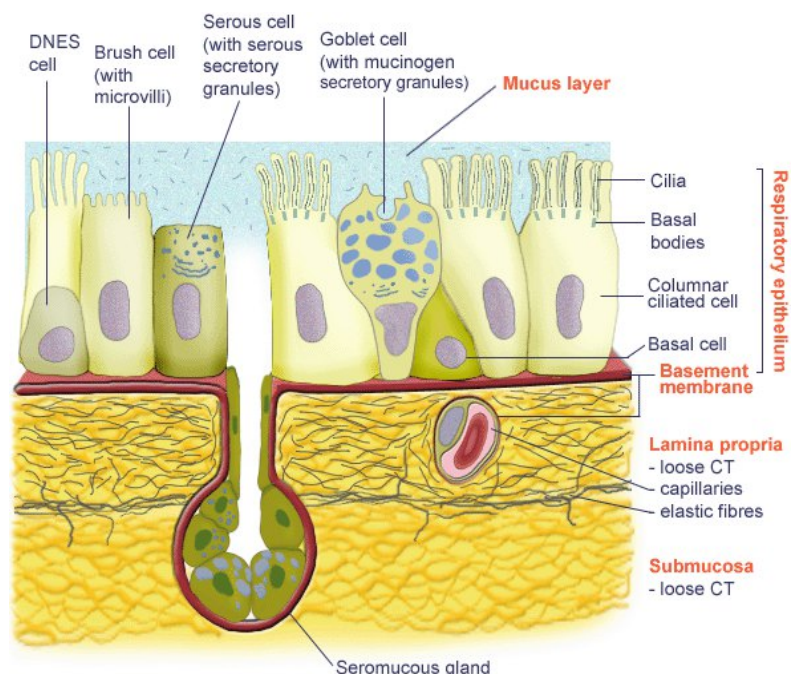
laminated, Pseudostratified epithelium composed of a limited number of cell types + goblet cells

	Olfactory epithelium	Respiratory epithelium
Types of cells	Bipolar neuron Supporting cells Basal cells Bowman's gland	Ciliated/nonciliated pseudostratified columnar epithelium Basal cells Mucin secreting Goblet cells
Cilia of bipolar neuron vs pseudotratiified columnar	Non-motile Radial Greater length Poor ultrastructure	Mobile

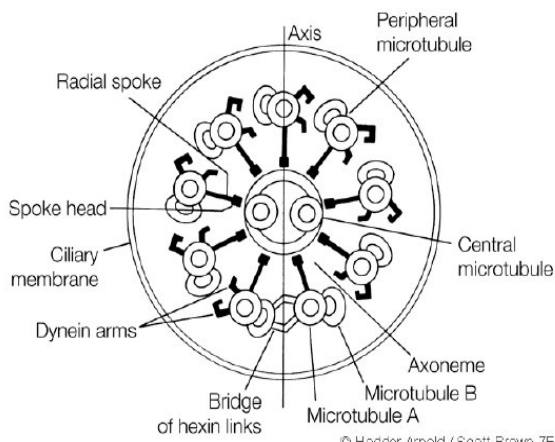
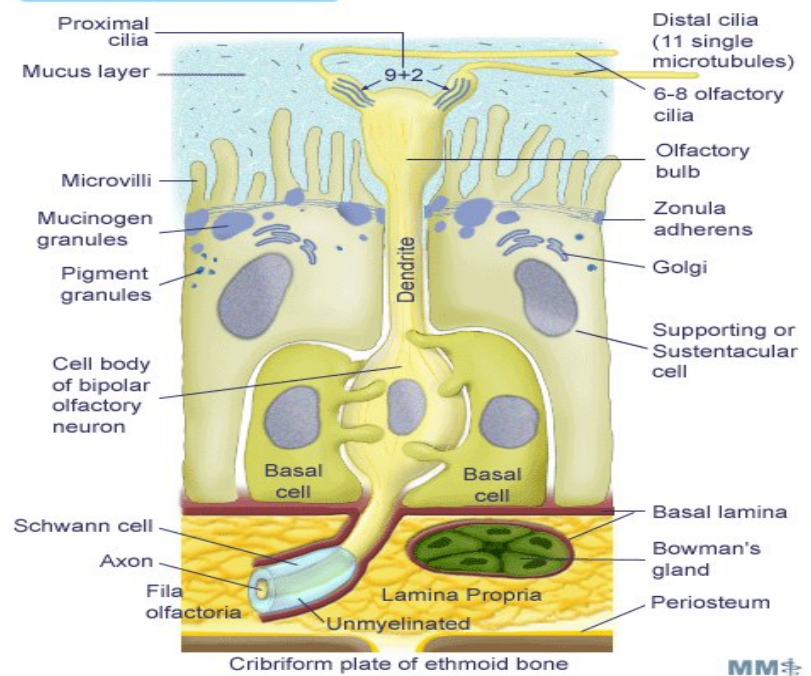
Olfactory bulb is highly organized with multiple layers (from outside in).

- Glomerular layer
- External plexiform layer
- Mitral cell layer
- Internal plexiform layer
- Granule cell layer

Note: The **mucoperichondrium** and **mucoperiosteum** of the **septum** are separate from that overlying the **maxillary crest**, reflecting their **embryological** development



Olfactory Epithelium



Lining of the nasal cavity (respiratory epithelium):

A. **Double Layered Mucous Blanket**

B. **Cell Components of respiratory epithelium :**

1. **Ciliated, Pseudostratified Columnar Epithelium:**

Anterior border begins at limen nasi

Each ciliated cell contains **50-200 cilia**

Ultrastructure of the cilia:

9 peripheral doublet + 2 central single organization of the microtubule

Each doublet has dynein arms extending outward between peripheral doublets

Dynein arms provide motion of the cilia

1. **brush cells with microvilli :**

Microvilli increase the surface area thus improving air humidification & warming

1. **basal cells: do not** extend to the **lumen**
2. **goblet cells (columnar: goblet cells 5:1)**

A. **basement membrane**

B. **lamina propria contains:**

1. Glandular structures:

Serous glands: responsible for humidification of air

Mucous glands: responsible for production of mucus along with goblet cells

1. Nervous structures which controls mucous secretions:

sympathetic: for **thin** mucus secretions

parasympathetic: for **thick** mucus secretions

1. vascular structures:

which helps in temperature modification of the inspired air

1. **Inflammatory cells**

Mucous Producing Glands:

Types:

- a. **goblet** cells (columnar cells, basal nucleus, secretory granules at lumen end)
- b. deep and superficial **seromucinous** glands (serous or mucous acini with cuboidal lined duct complexes)
- c. intraepithelial glands (20–50 mucous cells around a single duct)

Major Composition of Nasal Mucus:

1. 95% water: mainly from the **serous** glands; also **indirectly** from transudation from the **capillary network**.
2. 3% mucoglycoproteins(mucin); 2% salts
3. Immunoglobulins:
 - a) IgA: especially A₂, is a dimer, does not activate complement, on the surface, 70% of protein content
 - b) IgE?: on the surface, does not activate complement.
 - c) IgG: activates complement except G₄, if mucosa is breached.
 - d) IgM: if mucosa is breached
 - e) IgD
1. Interferon; inflammatory cells; complement; eosinophils, basophils, leukocytes.
2. **lysozymes**(bacteriolytic)produced from leukocytes and macrophages and works **only on bacteria without capsule**.

3. **lactoferrin** (bacteriostatic) by removing heavy metal ions it prevents growth of certain bacteria especially **staph and pseudomonas**.

But the mucus blanket does not contain IgE??

The mucous blanket is divided into **inner** and **outer** layers:

1. **Outer layer /gel phase:**

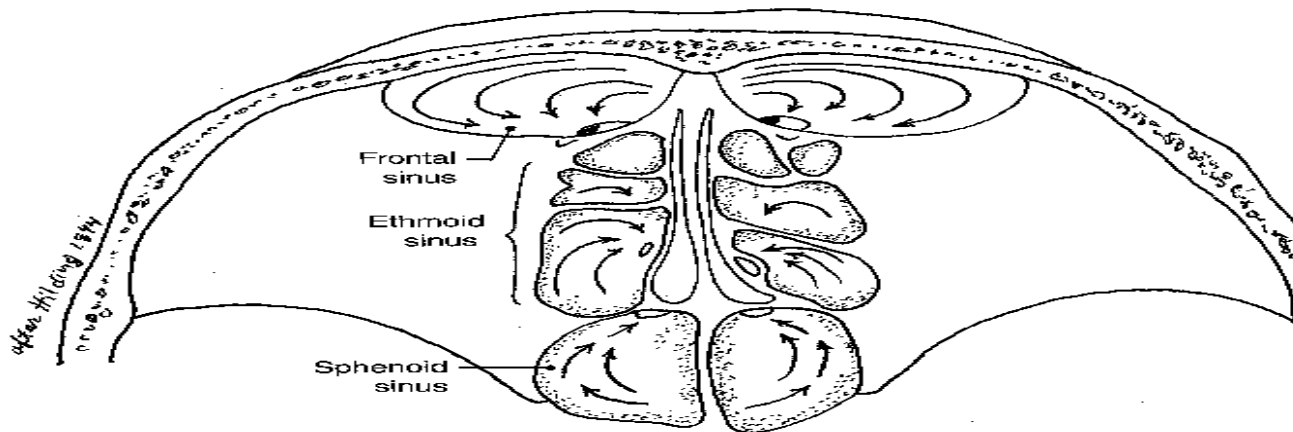
Produced by goblet cells + submucosal glands; lies on **top** of the nasal cilia

Glycoproteins give its **viscosity** & elasticity.

traps foreign particles matter

1. **Inner layer /sol phase:**

produced by **microvilli**; **surrounds** the cilia



less viscous & provides fluids that facilitates ciliary motility as well as the gel layer

The direction of mucus drainage from sinuses:

In all the sinuses, mucus moves toward the natural ostia.

a. **Maxillary sinus:**

mucociliary clearance (is spiral) begins at the **floor** and flows **against** gravity toward the **natural ostium** to empty into the ethmoidal infundibulum.

b. **Frontal sinus:**

Drains toward the ostium only from the **lateral** side.

Mucus **medial** to the ostium must course superiorly to join the lateral flow toward the ostium

c. **Sphenoid sinus:**

Flows in an **antigravitational** direction toward its ostium that drains into the sphenoethmoidal recess.

The direction of mucus drainage in relation to the Eustachian tube:

From **anterior** sinuses: Passes over the inferior turbinate and then anterior to the eustachian tube orifice

from **posterior** sinus secretions: Pass **posterior** to the eustachian tube

Oxygen tension

The PO₂ is lower in the maxillary sinuses than in the nose and it is lower still in the frontal sinuses.

If the ostium becomes blocked, the oxygen tension drops further.

Ciliary motion remains normal if the blood supply is adequate. If the blood supply is impaired, ciliary activity is reduced and stasis of secretions results.

Levels of nitrous oxide are higher in the sinuses than in the nasal cavity.

Pressure changes

Pressures in the maxillary sinus vary **with** respiration but lag behind by 0.2 sec.

There is little fluctuation when the nose is patent and the variation of pressure during quiet respiration is ± 4 pascals, which reaches 17-20 pascals on exercise.

If the nose is blocked, then pressure fluctuations are much more marked.

Ostium size

Blockage of the natural sinus ostium results in a reduction of ventilation and stasis of secretions.

An ostium below 2.5 mm predisposes to disease

Cilia:

Beats **10-20** cycle/**second (Hz)**

Energy is produced by conversion of ATP to ADP by the ATPase of the dynein arms and the reaction is dependent on Mg^{2+} ions. Motion is produced by the pair of outer microtubules sliding with respect to each other.

With **fast forward** beat & **slower return** beat

Migration rate of mucus 1cm/min (baily 3-35mm/min, essential 3-25mm/min)

replaced by newly produced mucus **2 or 3 times each hour**

The mucus is directed from **anterior to posterior** (toward the **nasopharynx**)

May be functionally assessed by saccharin test and by nasal brush biopsy

Factors affecting the ciliary activity:

A. The cilia move in the following situation:

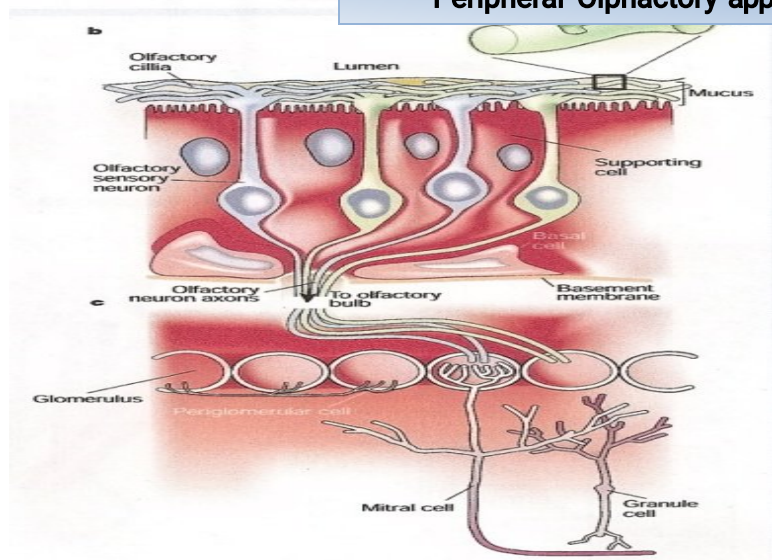
1. cilia will beat above pH 6.4 and will function in slightly alkaline fluids of pH 8.5 for long periods
2. Isotonic saline will preserve its activity
3. Acetylcholine increases the rate

A. The cilia activity decrease s in the following situations:

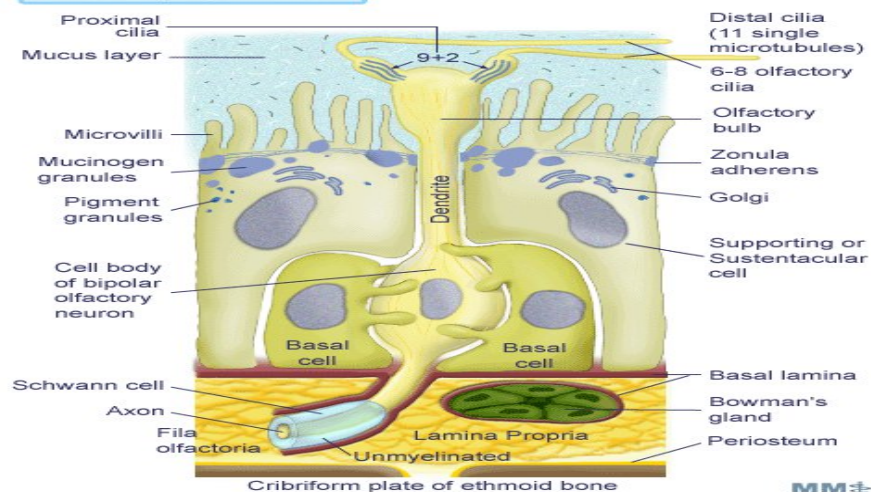
1. Drop in **humidity**
2. cease in **temperature** less than **10 C** or above **45 C**
3. **Adhesions** between the mucosal surfaces
4. URTI may damage the epithelium so that it sloughs away
5. **Ciliary** function may deteriorate with **age**
6. Saline solutions above 5% and below 0.2% will cause paralysis.
7. **K⁺ ions do not affect ciliary function except at non-physiological levels.**
8. Adrenaline decreases the rate
9. Cocaine hydrochloride in solutions above 10% cause immediate paralysis
10. Corticosteroids reduce the rate after 1 week of therapy.

Note: phenylephrine (-1 agonist) at high concentrations decrease ciliary beat function but at lower concentrations increase the rate

Peripheral Olfactory apparatus



Olfactory Epithelium



a- Cells of Olfactory epithelium:

1. Supporting cells:

flask-shaped; their nuclei are the **most superficial** in the epithelium

1. primary olfactory neurons; (olfactory receptor neurons)

bipolar in shape; non-motile cell has single odor receptor (not specialized as other senses)

their **nuclei** form a layer 2-8 cells thick in the **middle** zone of the **epithelium**

have **non**-motile cilia (Although these have the standard '9 + 2' fibril arrangement found in mobile cilia in other areas of the body)

the olfactory receptor neurons are derived from **ectoderm** & are unique in being replaced by **stem** cells every **30-50** days lifelong (from the basal cells)

1. Basal cells:

Situated deep in the epithelium in **juxtaposition** to the basal lamina.

Two types of cells can be distinguished morphologically:

1. Horizontal basal cells:

Resemble basal cells in other epithelia; they assemble keratin-containing intermediate filaments that attach to hemidesmosomes and mediate attachment to the basal lamina.

1. Globose basal cells:

Unique to the olfactory epithelium; they are relatively poorly characterized.

Proliferate at a much **higher** rate than any other cell type in the olfactory mucosa.

Ducts of Olfactory mucus gland: located in the **epithelium**

b- The lamina propria:

deep to the basal lamina (basement membrane); adherent to the underlying bone; contains:

- 1- **highly branched** specialized mucus-secreting cells of **Bowman's glands (seromucous gland):**

Tubular acinar glands.

Consists of an **acinus** in the **lamina propria** and a secretory **duct** going out through the **olfactory epithelium**.

They are **more** important in mucus secretion in nasal cavity than **goblet** cells

the odorant dissolve in the mucus produced by bowman's gland

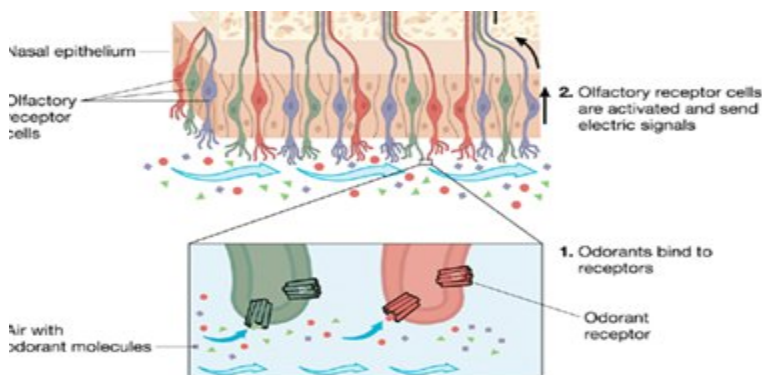
- 2- Blood vessels.

- 3- Fascicles of the olfactory nerve.

Note Olfactory **gland body** lies in the **submucosa** below the basement membrane while its duct lies in the Olfactory epithelium (netter p81)

	Goblet cell	Bowman's gland
Secret	Mucin	Seromucinous
Location	Epithelium	Subepithelium
More numerous	Sinuses	Nasal cavity
Distribution over the septum	Decrease from: anterior-posterior, superior-inferior	Vis versa

So secretory glands (bowman's gland) is not present in the sinuses



Transduction of odorant stimuli requires :

- 1) Dissolving of the stimuli into the **mucous** layer overlaying the Olfactory receptor (**1st** step in Odorant perception):

The mucosa is bathed in a **lipid**-rich secretion from the **Bowman's** glands, indicating that **lipid** solubility may be a critical factor in odor detection

- 2) **Diffusion** (possibly assisted by odorant-binding proteins) to the fine, tapering **immotile cilia** elaborated by the apical processes of the **sensory** neurons.

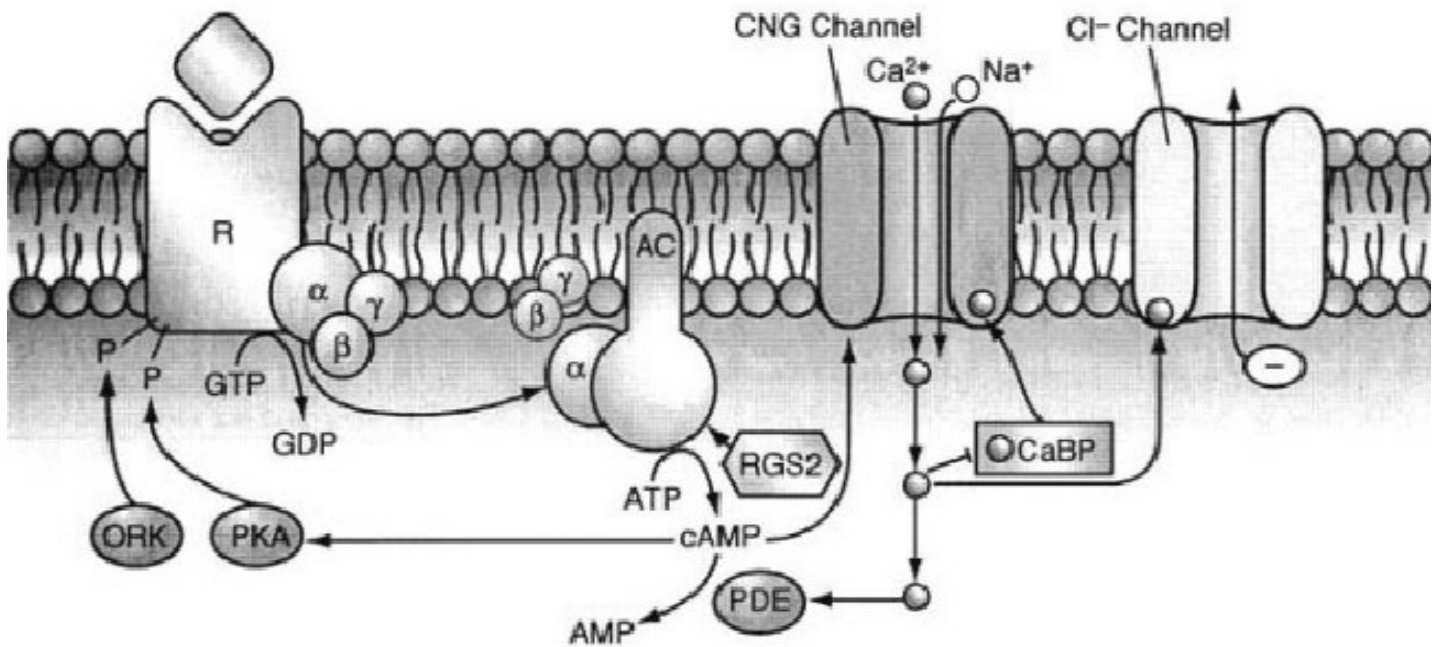
As this transduction process moves through the receptor cell membrane, several second messenger systems assist in depolarizing the cell and initiating the action potential.

Cyclic adenosine monophosphate (cAMP) and **inositol phosphate** (IP3) are the primary signaling pathways that can mediate olfactory transduction.

The **olfactory receptors** are members of **G-protein-coupled receptors (G_{PCR})**, This G protein seems to be

exclusively localized to the olfactory **epithelium**.

With the binding of the receptor to an odorant, adenylate cyclase is activated by G_{olf} and converts ATP into cAMP

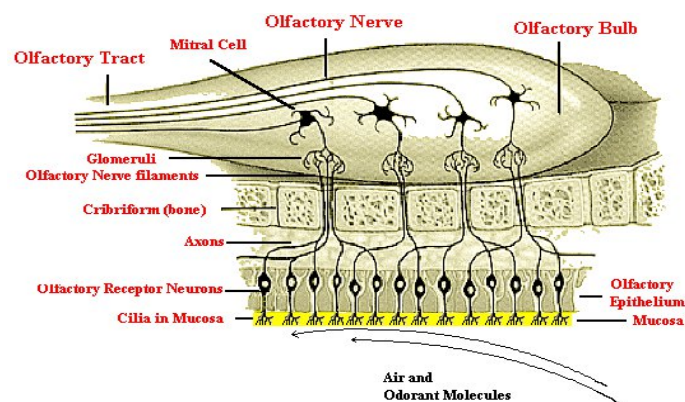


The cAMP then binds to a **Na^+ , Ca^{2+} ion channel** to allow influx of these ions, the cell depolarizes, and an action potential is produced.

Unlike the sensory epithelia of the auditory, vestibular, or gustatory systems, the receptor cell of the olfactory epithelium is a **bona fide** neuron

Each olfactory receptor cell has a single slim unmyelinated axon

Unmyelinated axon of olfactory receptor cell form **myelinated fascicles** (pass through lamina propria) which then form olfactory **fila (bundles)** that pass through the 15-20 foramina of cribriform plate into the **inferior** surface of the **Olfactory bulb** tract through **trigone hypothalamus, amygdale, hippocampus, piriform cortex**.



Each bundle carries tubular sheath of dura and pia which may be sheared in head injury leading to CSF leak and destruction of olfaction

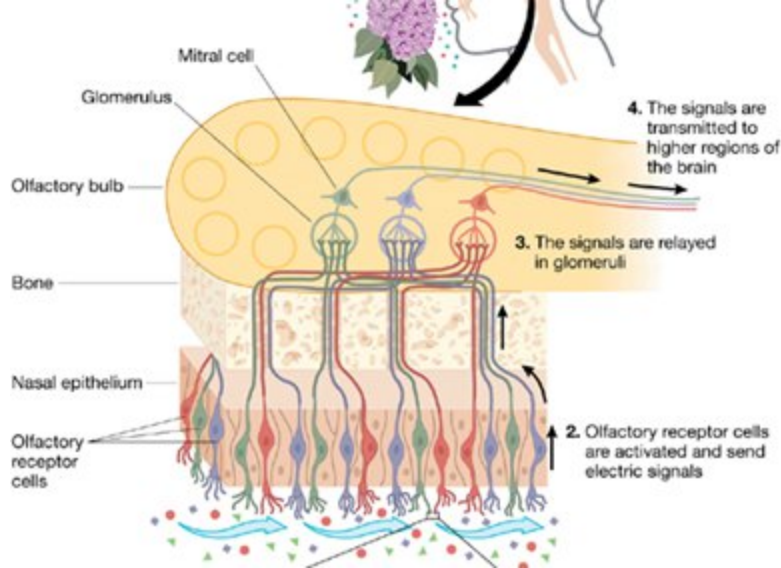
Note:

The Cell **body** of olfactory neuron is in the nasal mucosa

Axon goes through the cribriform plate

Anastomosis occurs in the Olfactory bulb

Central Olfactory apparatus



Fibers synapse in a structure called glomerus of the olfactory bulb with the dendrites of the mitral cells (2nd order neuron)

So the olfactory bulb is the 1st relay station for Olfactory input

Axon of **mitral** cells forms the olfactory Nerve

With increasing age the olfactory area is encroached upon by **respiratory** epithelium

Each zone contains a **group** of **different** olfactory **receptor** subtypes that seem to be confined within the **designated zone**.

Receptor cells of the same type are randomly distributed in the nasal mucosa but converge on the same glomerulus. In the glomerulus the receptor nerve endings excite mitral cells that forward the signal to higher regions of the brain with maintained specificity.

These zones are then **reproduced** by receptor projections to the olfactory bulb.

The axons from each identical olfactory receptor subtype converge and synapse with the mitral cells within **only** a few **glomeruli** of each olfactory bulb.

Therefore, a **specific odorant** may activate certain olfactory **receptor** types that then send signals to specific **glomeruli**, creating a pattern of activity much like other sensory systems in the brain.

Individuals with the **inability** to perceive particular odorants (**specific anosmia**) have been associated with **loss** of **specific genes** (receptor specificity for odorants)

General features of olfaction:

Ammonia is a strong stimulus of the trigeminal nerve

Adaptation to odor can occur within 1-5 min

If two odors were mixed the sum of the intensity will be less than the two individually perceived intensities and is dominated by the stronger component.

Cross adaptations are present between odors at high concentrations, whereas cross facilitations occur near threshold values

Odor association tend to stay longer in the memory than the associations from other senses
Olfaction helps two aspects of eating: the recognition of food types and the initiation of digestion. Initiation of digestion is mediated via the lateral and ventromedial hypothalamus, causes salivation and increases output of gastric acid and enzymes.

Gender issues:

Females are better in odor identification than men.

Female sense of odor is more acute at ovulation & less during menstruation.

A familial lack of perception to certain odors is more common in males.

Age issue:

Children

Children as young as 6 days of age are able to recognize their mother by smell.

Odor identification is **unreliable** in **young** children.

The ability to dislike unpleasant odors develops at the age of 4 years.

Elderly

Rapid **drop** in odor identification occurs in the **7th** decade

Notes:

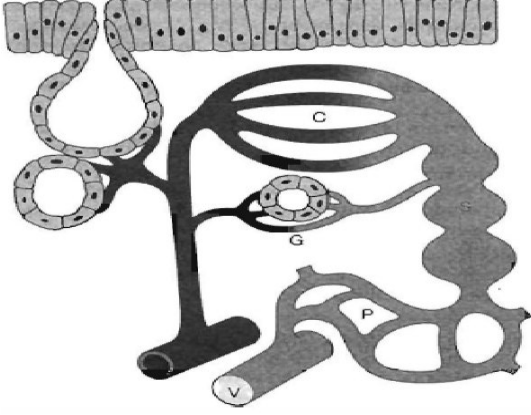
Most common cause of taste loss is olfactory dysfunction

Dysosmia is perception of unpleasant odors

Phantosmia is perception of and odor in the absence of a stimulus

Parosmia is distorted perception of odor

Cacosmia is perception of normal odors as bad smell by brain rather than by olfactory nerve



Nasal vasculature:

The nose is rigid box **without** constricting smooth muscle so changes in airway are produced by **alterations** in blood flow in **resistance** (arteries & arteriols) and pooling of blood in **capacitance** vessels (veins & venioles) .

Blood is shunted between the arteries and veins in **submucosa**

components of the **Nasal vascular system** :

1. precapillary resistance vessel (arteries & arteriols):

The maxillary artery is the main feeding vessel

Note: The maxillary artery can be found in the pterygopalatine fossa by a transantral or endoscopic approach.

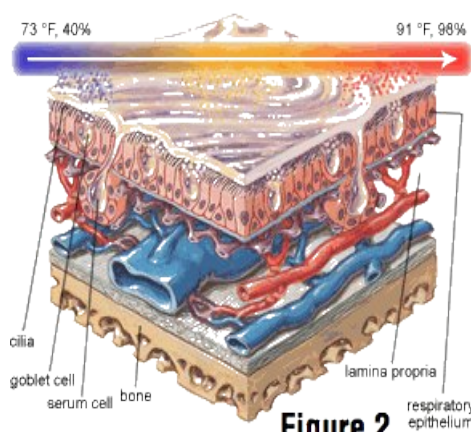


Figure 2

The flow is forward through the nose

1. capillaries (the most **superficial** component)
2. **sinusoids** (venous erectile tissue)
3. venous plexus
4. arteriovenous anastomoses
5. venules (the **deepest** component)

Towards the surface:

arteries branch into: arterioles (lack an elastic lamina) and end in capillaries

capillaries:

Run **parallel** and **just below** the surface epithelium.

They also run around **mucous glands**

Capillaries (in the turbinates) empties into: sinusoid: venous plexus: venules

Sinusoid system:

location:

- a- nasal **submucosa**;
- b- turbinate (especially the **inferior** turbinate)
- c- present on the septum adjacent to:
 - 1. the **inferior** turbinate
 - 2. On the **most anterior** septum.

Valveless; Receive **both** arterial and venous blood.

It's filling & emptying cause mucosal swelling & shrinkage resulting in changes in nasal **resistance** to airflow & control of airflow into the olfactory cleft.

The sinusoids themselves contain little or **no** muscles & thus **unresponsive** to **adrenaline**

The degree of the venous sinusoidal filling is controlled by cushion veins

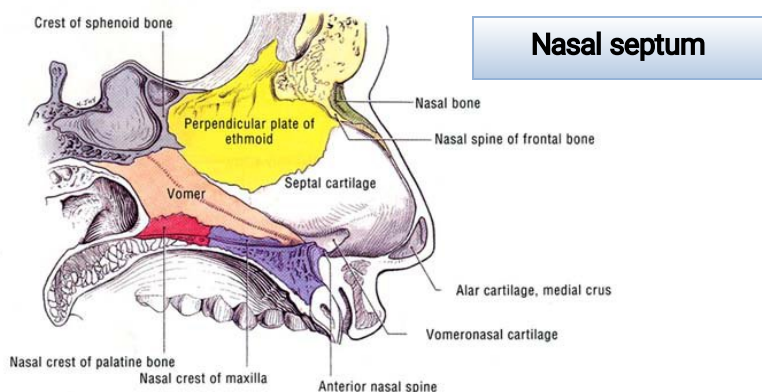
Cushion veins:

Located at the **distant** end of the sinusoid; Have very thick **longitudinal** muscular wall

Under the influence of both sympathetic & parasympathetic innervations

Upon reduction of **sympathetic** stimulation or increase in **parasympathetic** stimulation the veins punch up (but they do not close the lumen completely) , allowing proximal venous sinusoid to distend, **increasing nasal** resistance

Produce **histological** appearance similar to **cavernous hemangioma**



Surface area of the septum in adults $30-35 \text{ cm}^2$

Mucosal surface area in adults 1700 mm^2 , infants 450 mm^2

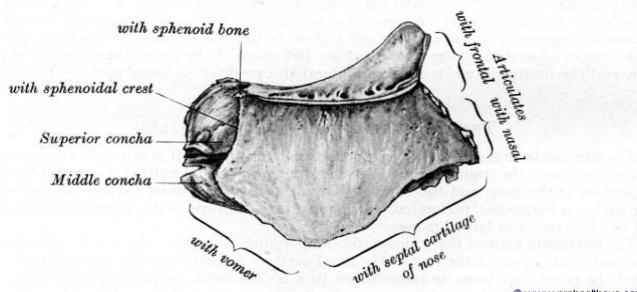
Septum develops from the frontonasal process

Cleft lip and palate are the most congenital conditions with septal involvement (missing basal support of the septum and due to surgical closure leading to scar formation)

It is made of 4 bones & 1 cartilage:

1. Quadrilateral cartilage

FIG. 367.—The perpendicular plate of the ethmoid bone. Right lateral aspect. Shown after removal of the right labyrinth.



Thickness:

- o 3-4 mm centrally
- o 4-8 mm anteroinferiorly

1. Perpendicular plate of the ethmoid
2. Vomer
3. Crest of Palatine bone
4. Crest of maxilla and Anterior nasal spine of the maxilla

Septal cartilage-**ethmoid** articulation is **End to End**

Septal cartilage-**maxillary crest** articulation is **tongue-groove**

Caudal part of the septum (quadrilateral cartilage) extends **beyond nasal** spine

Histology:

ciliated and non ciliated pseudostratified columnar cells with each cell bearing 300-400 microvilli (to increase surface area to prevent dryness)

basal pluripotent stem cells

Septal hematoma

Internal nasal bleeding that cannot escape through the mucous membranes or skin.

These haematomas can be found in the septum or around the triangular cartilages.

A septal haematoma should be drained to avoid an abscess development.

If an incision in the mucosa is made to drain a haematoma, it should be a horizontal incision to avoid disruption of the mucociliary transport.

Septal abscess

The most common cause of a septal abscess is a septal haematoma.

Three to five days after the trauma that caused the haematoma, a fever and nasal blockage may occur which, at that time, will not be associated with the trauma and frequently is interpreted as flu.

The treatment consists of drainage of the abscess and antibiotics

Septal fractures

Frontal trauma will frequently result in vertical fractures, whereas lateral trauma can give horizontal fractures

In vertical fractures in particular, the consequent scar can impede mucociliary transport.

Incomplete fractures can lead to bending of the cartilage

In vertical fractures, there may be a luxation or subluxation of the caudal part of the quadrilateral cartilage.

In case of a luxation, the caudal rim of the cartilage can be seen to the left or to the right of the columella.

In case of a subluxation, this is only seen after the tip of the nose is lifted.

Mucosal trauma

Surgery is probably the most common cause

Can lead to severe atrophy of the mucosa which may result in atrophic rhinitis with symptoms such as fetor, crusting, congestion, epistaxis and headache.

Too vigorous surgery of the inferior turbinate can change the aerodynamics of the nose in such a way that serious trauma of the mucosa may result.

Septal perforation

Septal perforations are either the result of trauma or systemic disease.

When there is no skeleton to prevent drying of the back of the mucosa opposite to the mucosal laceration, the mucosa on both sides of the septum will disappear and this leads to a perforation. Examples are cautery for nose bleeding, nose picking and cocaine abuse.

In submucosal skeleton resections, such as the Killian procedure, a septum perforation is a common complication,

Although septal perforations can be asymptomatic, they may present to the surgeon with debilitating symptoms such as nasal blockage, atrophy of the mucosa, dryness, crusting, nose bleeding, whistling and headache.

The nose blockage and whistling are related to abnormal aerodynamics.

The other symptoms are the result of the poor condition of the mucosa, which is worse around the perforation. Perforations in the anterior part of the septum present more symptoms than perforations in the posterior part.

Small perforations have a stronger tendency to produce sounds than larger ones.

In large perforations, the patient's complaints can be mild.

Closure of a septal perforation is difficult due to lack of material to reconstruct the skeleton and the mucosa.

Vital tissues are brought into the perforation to reconstruct the skeleton and the lining of the septum and to replace the atrophic tissues around the perforation. For the mucosa, pedicled flaps are used.

When closure of a perforation is difficult, conservative treatment might be an alternative. Crusting and infection can be reduced by douching the nose with saline. A silastic button may have a positive effect by improving the aerodynamics and protecting the edges of the perforation, although the button itself can be the cause of crusting.

Septal disease in systemic disorders

Hereditary haemorrhagic telangiectasia or Osler Weber-Rendu disease is an autosomal dominant condition: There is a deficiency of the muscle or elastic tissue in the wall of the blood vessels. Therefore, they cannot contract when severed. This can lead to telangiectasia in the skin, the lips, nail beds, the mouth tongue and the nose. The gastrointestinal tract and the lungs can also be involved.

In arteriosclerosis, Osler-Weber-Rendu disease and juvenile angiofibroma, nasal bleeding can be difficult to control.

Infectious diseases : Syphilis, Tuberculosis, Leprosy, Diphtheria

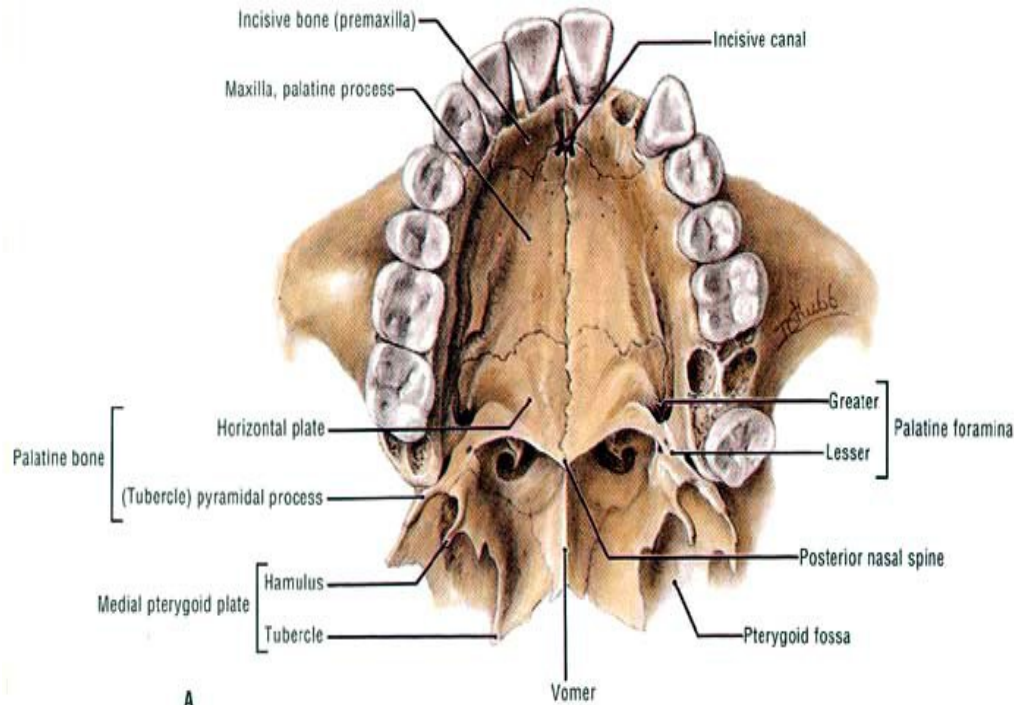
Auto-immune: Sarcoidosis, Lupus erythematosus, Takayasu disease, Wegener's granulomatosis

Developmental disturbances:

As a rule of thumb, the length of the nose should be approximately a third of the distance between the hairline above the forehead and the lower border of the chin.

Indications for septoplasty

Nasal obstruction, crusting, rhinorrhoea, post-nasal discharge, recurrent sinus pressure or pain, epistaxis, headache, snoring and sleep apnoea.



The indications for corrections for aesthetic reasons are in general more straight forward than those for functional reason

Bony lateral nasal wall:

- 1) Maxilla: antero-inferior
- 2) Perpendicular palate of the palatine bone: posterior
- 3) Inferior turbinate: overlaying inferior over 1+2
- 4) Ethmoid (superior and middle turbinate): superior

Note the medial pterygoid plate is not part of the nasal lateral wall

Floor of the nasal cavity:

- 1) Palatine process of the maxilla
- 2) Horizontal process of the palatine bone

Nasal choana

- 1) Superiorly: body of sphenoid with overlapping alae of the vomer & vaginal process of the medial pterygoid plate
- 2) Lateral wall: medial pterygoid plate
- 3) Medial wall: posterior part of the septum (vomer)
- 4) Floor: horizontal plate of the palatine bone

Blood & nerve supply of the nose

External Nose: see netter p 288

A. (mainly): Facial artery branches :

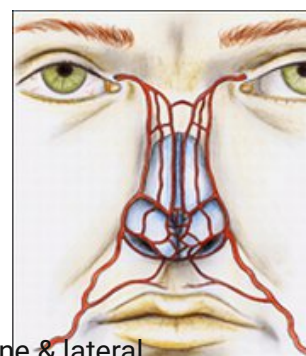
Superior labial artery : columella and lateral nasal wall

Angular artery : nasal side wall, nasal tip, and nasal dorsum

A. Maxillary artery: Infra-orbital artery (lateral side of the nose)

B. Ophthalmic artery:

1. Dorsal branch (nasal bridge (Dorsum))
2. External branch of the anterior ethmoid artery (junction between the nasal bone & lateral cartilage)



There are significant anastomoses between these vessels on each side and between the right and left sides

Nerve Supply

The skin of the external nose receives its sensory supply from the two upper divisions of the trigeminal Nerve

Part of the nose	Nerve supply
lateral surface of the root of the nose	infratrochlear branch of ophthalmic
skin over the root and dorsum as far as the tip of the nose	external nasal branch of ophthalmic
anterior lateral wall	pes anserinus minor & anterior superior alveolar branch

nasal alae	external nasal branches of infraorbital branch of maxillary
nasal vestibule	internal nasal branches of infraorbital branch of maxillary

pes anserinus minor: made of anastomosis between inferior palpebral and superior labial branches of the maxillary division of trigeminal nerve with superior buccal branches of the facial nerve **see page 849 essential**

Nasal cavity

External carotid artery system

Internal maxillary artery: (supplies 90% of nasal mucosa)

Sphenopalatine artery via sphenopalatine foramen: (main blood supply)

- o lateral nasal artery, supplying lateral nasal wall;
- o posterior septal artery, supplying posterior aspect of septum

Descending palatine artery: forms the greater and lesser palatine arteries; supplies lower portion of the nasal cavity

Greater palatine artery: passes inferiorly through greater palatine canal and foramen, travels within hard palate mucosa; bilateral arteries meet in midline and travel through single incisive foramen back into nasal cavity

Internal carotid artery system : ophthalmic artery enters orbit and gives off anterior and posterior ethmoid arteries; courses via anterior and posterior ethmoidal canal, takes an intracranial course and then turns inferiorly over the cribriform plate

Anterior ethmoid artery: supplies lateral and anterior one-third of nasal cavity; anastomoses with sphenopalatine artery (also known as nasopalatine artery; most common artery injured in septoplasty surgery, causing hematomas)

Posterior ethmoid artery: supplies small portion of superior turbinate and posterior septum

Innervation

Nasociliary nerve

Branch of ophthalmic division of cranial nerve (CN) V (CNV1)

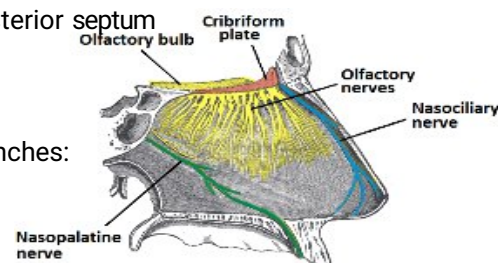
Arises in the lateral wall of cavernous sinus and enters orbit and gives off two branches:

1. Infratrochlear nerve: Supplies skin at the medial angle of eyelid
2. Anterior ethmoidal nerve:

Leaves orbit with anterior ethmoidal artery

Supplies anterior superior nasal cavity, anterior ends of middle and inferior turbinate and corresponding septum; also region anterior to the superior turbinate

Leaves nasal cavity and supplies skin on dorsum of the tip of nose



Maxillary nerve (CN V2)

- Exits middle cranial fossa via foramen rotundum

1. Pterygopalatine (sphenopalatine) ganglion: contains parasympathetic, sympathetic, and sensory nerves
 - Lateral posterior superior nasal branch: Supplies posterior portion of superior and middle turbinates, posterior ethmoid cells
 - Medial posterior superior nasal branch: Cross anterior surface of sphenoid; roof of nasal cavity; posterior septum
 - Nasopalatine nerve: Supplies anterior hard palate
 - Greater palatine nerve: Supplies mucous membrane over posterior portion of inferior turbinate and middle and inferior meatus

- Infraorbital branch

Supplies portion of vestibule of the nose; anterior portion of inferior meatus; part of the floor of nasal cavity

Nasal septum

The external and internal carotid arteries are responsible for the rich blood supply to the nose.

Arterial Branch	Main blood artery	foramen	Supplied area
Anterior & posterior Ethmoidal artery	Ophthalmic artery	Cribriform plate foramen	Superior part of the septum
Septal branch of Sphenopalatine artery	3 rd part of the maxillary artery	Sphenopalatine foramen	Posterior inferior part
Greater palatine artery	3 rd part of the maxillary artery (Descending palatine artery)	Greater palatine canal then Incisive canal	Anterior inferior part Floor of the nose
Labial branch	Facial artery		Anterior part

Note the **blood** supply of the **cartilaginous** nasal septum is **directly** via overlaying **mucoperichondrium**



Anterior & posterior ethmoidal arteries are the **terminal** branches of the **internal** carotid artery
Sphenoplatine artery is the **main** blood supply of the septum

Little's area (kiesselbach's plexus) is an anastomosis of the:

1. **Anterior** ethmoid artery
2. Septal branch of the greater palatine artery
3. Septal branch of **superior** labial artery
4. Septal branch of sphenoplatine artery

So **all** blood vessels supplying the septum participate in the formation of **kiesselbach plexus** **except** the posterior ethmoidal artery

Woodruff plexus (nasopharyngeal plexus):

Anastomosis of posterior nasal, posterior ethmoid, sphenopalatine, and ascending pharyngeal arteries along posterior lateral nasal wall inferior to the inferior turbinate

Located at the posterior 1cm of the nasal floor + inferior meatus + inferior turbinates + middle meatus

Responsible for posterior bleeds, associated with high blood pressure

Note: maxillary ostia is the dividing line between anterior and posterior bleeding

Septal Nerve Supply

See p 88-92 netter

The **maxillary** division of the trigeminal nerve provides the sensory supply to the **majority** of the nasal septum

1. **Nasopalatine nerve (long sphenopalatine nerve):**

Medial to branch of the sphenopalatine artery

One branch of the [pterygopalatine ganglion](#)

supplies the **bulk** of the **bony** septum

entering the nasal cavity via the sphenopalatine foramen

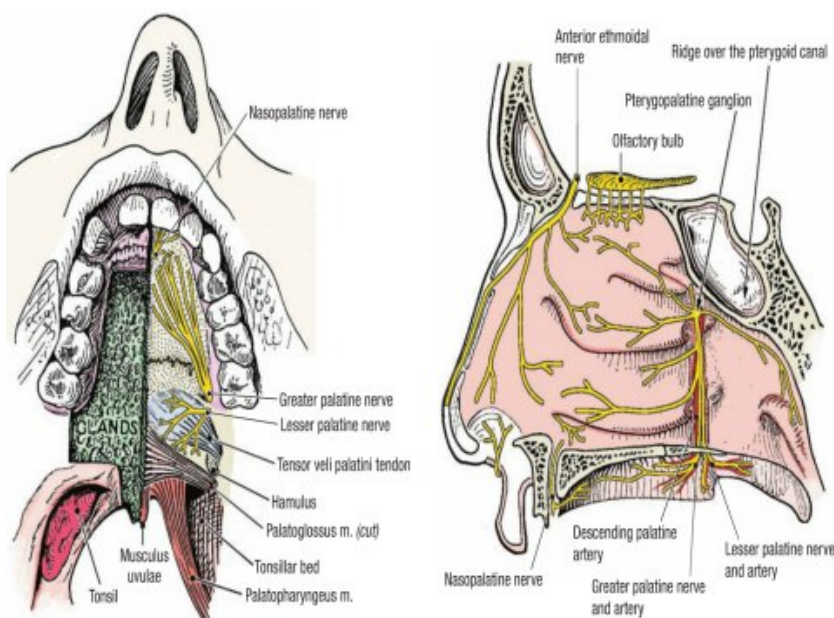
passing medially across the roof of the upper septum

Running down and forwards to the incisive canal to reach the hard palate.

1. **Anterior ethmoidal branch of the Nasociliary nerve:**

Supply the anterosuperior part of the septum

2.



anterior superior alveolar nerve :

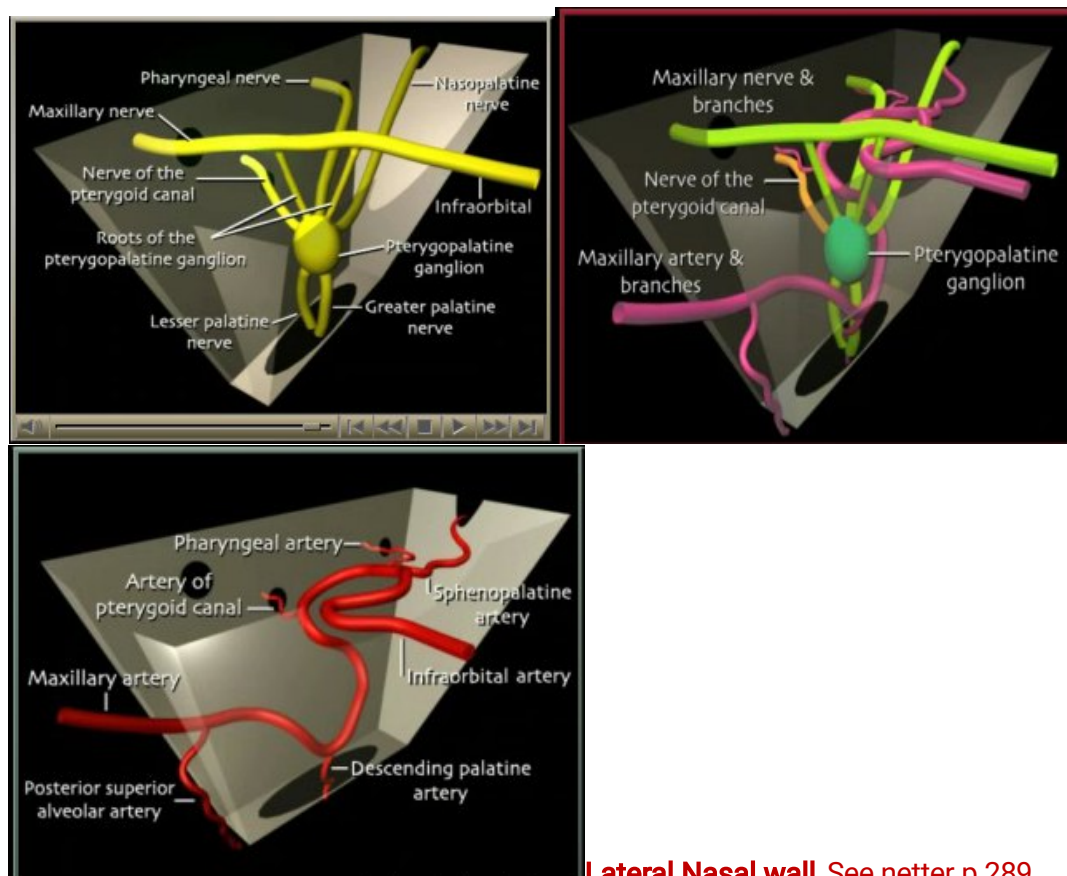
supply the smaller anteroinferior portion

3. **nerve to pterygoid canal and posterior inferior branch of the anterior palatine nerve:**

supply a small portion posterior inferior

4. olfactory nerve:

The olfactory epithelium covers the **inferior** surface of the **cribriform plate** spreading down to cover a variable area on the **upper** septum and **adjacent** lateral wall (over the medial surface of the superior concha)



Lateral Nasal wall See netter p 289

Branches:

Lateral nasal branches of the anterior & posterior ethmoid arteries: Superior part of the lateral nasal wall

Lateral nasal branches of the sphenopalatine artery:

Posterior $\frac{1}{2}$ of **inferior** and **middle** turbinates.

Enters through the sphenopalatine foramen which lies just **inferior** to the **horizontal** attachment of **middle** turbinate

May be damaged in excessive enlargement of a middle meatal antrostomy.

Its branches to the respective turbinates and meatus enter **posteriorly**

On the conchae, the vessels are **partially embedded** in deep grooves.

In the **inferior meatus**, the sphenopalatine branch dips **below the level of the palate** to re-emerge **anteriorly**, leaving the **central** portion of the meatus relatively **avascular**

Facial artery: Anterior part

Greater palatine: Part of the lateral wall adjacent to the palate

Note: the main blood supply of the lateral nasal wall is through the sphenopalatine artery

There is considerable overlap between the internal and external carotid arterial systems on each side and between the right and left sides which may complicate attempts at arterial ligation in the management of epistaxis.

The vascular supply to the nose is well-developed and this is enhanced by cavernous plexus found in the lamina propria, in particular on the inferior and middle turbinates, which is controlled autonomically.

The veins of the plexus are between 0.1 and 0.5 mm wide and anastomose with each other.

In addition, numerous arteriovenous anastomoses are found in the deep mucosa and around the glands.

Venous drainage is to the **sphenopalatine veins** via facial and ophthalmic vessels,

intracranially via the ethmoidal veins to veins on the dura and to the superior sagittal sinus via the foramen caecum

Lateral wall nerve supply

Superior concha: olfactory supply

Anterosuperior: anterior ethmoidal nerve

Posterior:

posterior superior lateral nasal branch (branches of the pterygopalatine ganglion)

Posterior inferior lateral nasal branch (greater palatine nerve)

Anterior: internal nasal branch of infraorbital nerve

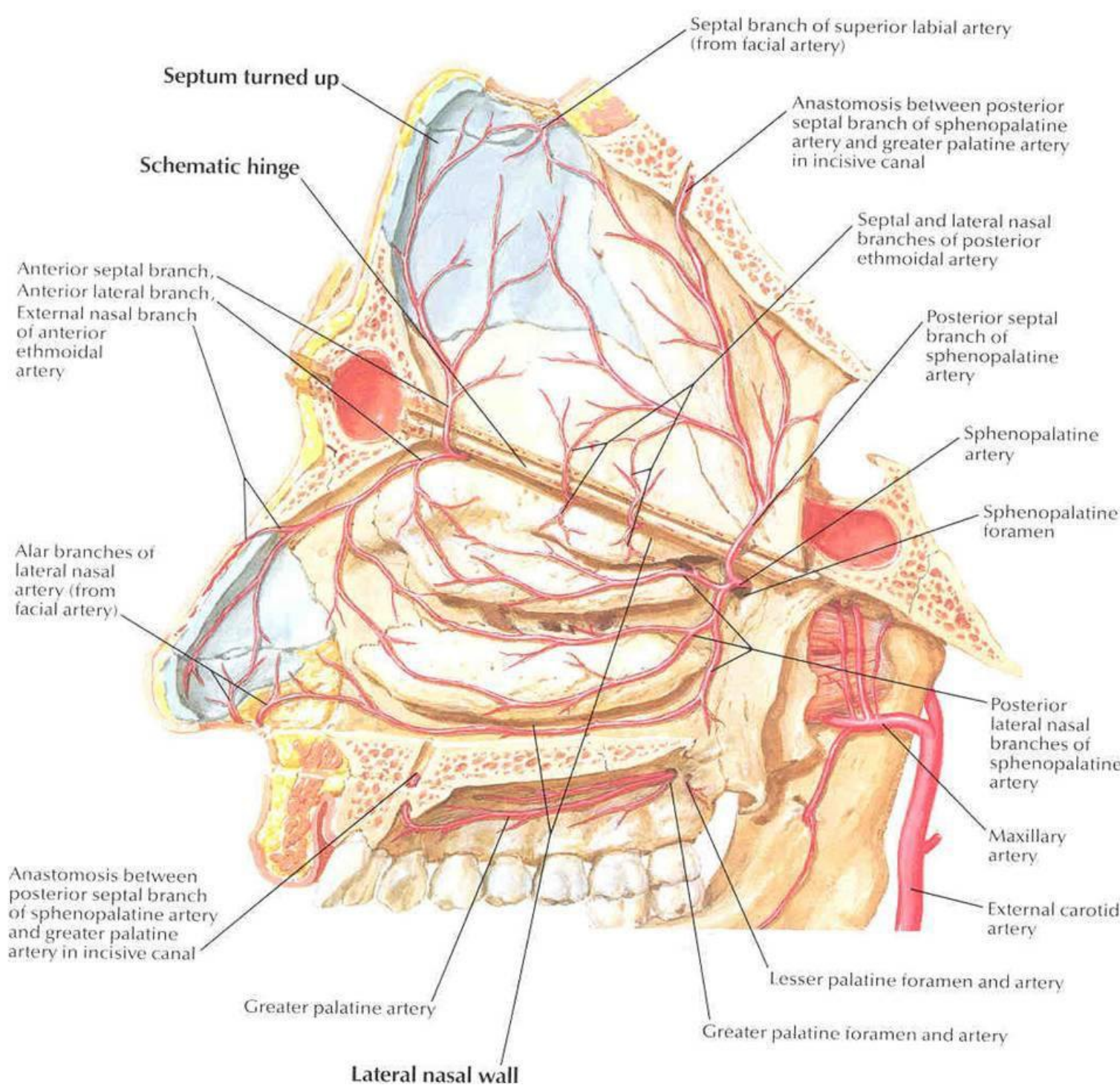
Anterior inferior meatus: The anterior superior alveolar nerve

may be damaged in inferior meatal surgery

Inferior turbinate:

mainly greater palatine and the rest

by anterior ethmoidal nerve



Ethmoid sinus:

1. Anterior ethmoid artery
2. Posterior ethmoid artery
3. Sphenopalatine artery

Sphenoid sinus:

1. Posterior ethmoid artery
2. Sphenopalatine artery : antero-inferior face of the sphenoid sinus

Frontal sinus:

1. Supra-orbital artery
2. Anterior ethmoid artery

Maxillary sinus:

1. Branches from facial artery
2. Branches from maxillary artery
 - a. Infra-orbital branch of maxillary artery
 - b. Greater palatine branch of maxillary artery

In summary:

Ophthalmic branches:

1. posterior ethmoid artery
2. anterior ethmoid artery + external branch
3. Dorsal branch
4. supra-orbital branch

Maxillary:

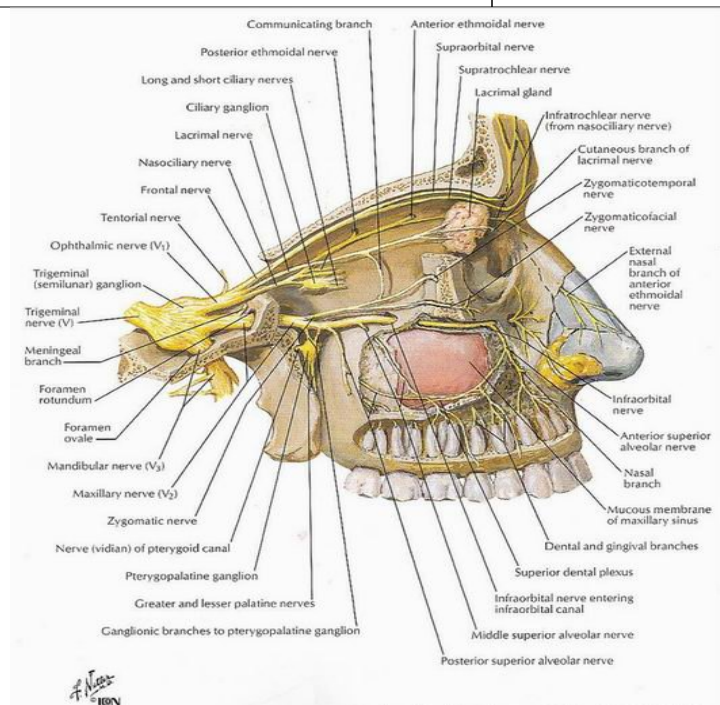
1. infra-orbital artery
2. sphenoplatine artery
3. greater palatine artery

Facial:

1. alar branch of superior labial artery
2. lateral nasal branch of angular artery

Sinuses nerve supply:

Name of sinus	Nerve supply
Frontal	Supraorbital branch Frontal Nerve (branch of ophthalmic)
Anterior & posterior ethmoid & sphenoid	Anterior & posterior ethmoid Nerves & orbital branches of Pterygopalatine ganglion
Maxillary	
Anterior surface	Anterior superior alveolar nerve
Lateral surface	Middle superior alveolar nerve
Posteriomedial	Greater palatine nerve
Roof	Perforating branches from the infra-orbital Nerve



Floor (hard & soft palate) innervation :

Nasopalatine	Central incisor to the canine
--------------	-------------------------------

Greater palatine	Premolar – end of hard palate
Lesser palatine	Soft palate

Venous drainage of the nose

Venous system is valveless.

Veins arise from dense venous net work (**cavernous sinus** in the **submucosa**) Accompany arteries & drain into the following:

1. **ethmoidal veins communicate with:**

veins of the orbital surface of the frontal lobe of the brain

superior sagittal sinus: direct intracranial connections through the foramen caecum

ophthalmic plexus drain via:

- a) **Superior** ophthalmic plexus into the **cavernous** sinus
- b) **Inferior** ophthalmic plexus into the **pterygoid** plexus

1. **Sphenopalatine vein (via facial and ophthalmic vessels)** drains via sphenopalatine foramen into pterygoid plexus.

2. **facial veins**

a) **Anterior** facial vein:

Drain via the **common** facial vein into the **internal** jugular vein

Communicates with cavernous sinus via ophthalmic veins, infraorbital and deep facial veins, and the pterygoid plexus

a) **Angular** facial vein: drains external nose via ophthalmic vein to cavernous sinus

Lymphatic drainage of the nose

	Area	arteries	Nerves
Outer nasal surface	Root of the nose	Dorsal artery	Infra-trochlear Nerve
	Dorsum	External branch of anterior ethmoid	External branch of anterior ethmoid
	Lateral side	Infra-orbital artery	pes anserinus minor & anterior superior alveolar branch

	Alar area	Alar branch of superior labial Lateral nasal branch of angular branch of facial	External nasal branch of the infraorbital branch
Septum	Superior-anterior	Anterior ethmoidal artery	Anterior ethmoid nerve
	Superior-posterior	Posterior ethmoidal artery	Olphactory nerve
	Posterior-inferior	Sphenopalatine artery	Nasopalatine nerve (short+ long sphenopalatine nerve)
	Anterior-inferior	Superior labial artery	Superior anterior alveolar nerve
Lateral wall	Superior-anterior	Lateral superior nasal branches of Anterior ethmoid artery	Anterior ethmoid nerve
	Superior-posterior	Lateral superior nasal branches of posterior ethmoid artery	Olphactory nerve
	Posterior-inferior	Lateral inferior nasal branches of sphenopalatine artery	posterior superior lateral nasal branch (branches of the pterygopalatine ganglion) Posterior inferior lateral nasal branch (greater palatine nerve)
	Anterior inferior	Superior labial artery	Internal nasal branch of infraorbital Anterior superior alveolar nerve
	Lateral wall adjacent to the palate	Greater palatine artery	

Anterior 1/3: submental +submandibular LNs

Posterior 2/3: retropharyngeal +superior deep cervical LNs

The major differences are:

Alar area: supplied by facial artery and maxillary branch of trigeminal nerve

Sphenopalatine artery supply posterior part of the nose (both the lateral + septum)

Nerve equivalent to sphenopalatine: nasopalatine, posterior superior lateral nasal
branches of the ganglion & posterior lateral branch of greater palatine