Respiratory System

Sheet 1

Subject | Anatomy

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Corrected by | …

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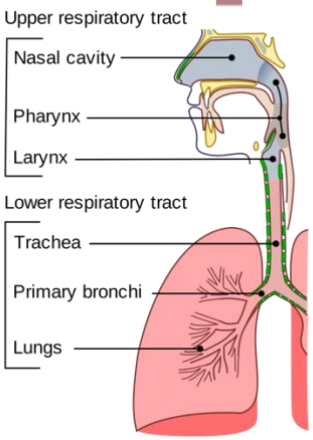
Make sure you watch the video of 2016 along with this sheet.

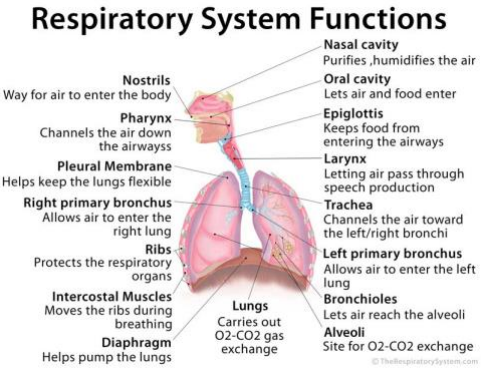


Introduction

First part of the respiratory system – Gross Anatomy

1. Starting from the **Nose** (nasal cavity).
2. **Pharynx** (Nasopharynx, oropharynx and laryngopharynx).
3. **Larynx**, box of cartilage where the phonation or the articulation occurs since it contains true vocal cords that are responsible of speech.
4. **Trachea**
5. **Bronchi** (main left bronchus and main right bronchus, both branch from the trachea) bronchi is the plural of bronchus
6. **Bronchioles** located inside each lung.
7. **Alveoli**, billions of air sacs which are formed at the end of each bronchiole, responsible for gas exchange supported and surrounded by the largest network of blood capillaries in our body to give a large surface area for gas exchange.
8. **Pleura** with both parietal and visceral parts surrounding each lung. Similar to the pericardium surrounding the heart.
9. **Hilum**, the place where the bronchi and blood vessels enter the lung and veins exit
10. **Nerves and Lymphatics**

The Nasal Cavity



Functions of the respiratory system:

1. **Gas exchange**, which occurs in the alveolar-capillary membrane.

What is respiration?

Respiration is the process of breathing:
- Inspiration: filling of lungs with Oxygen, which needs effort (muscle contraction).
- Expiration: the exhalation of breath from the lung, which is usually passive. Any voice abnormalities, vocal cord movements (i.e. wheezing) are often heard during expiration.

- **Respiratory rate (RR)**

Normal Respiration rate: 18-22 per minute.
this rate is variable upon physical activities, it increases in exercise (Deep) and decreases in rest.

Children has a high RR, more than 40 times per minute, rapid respiration.

***First thing to check while being in the ER is the respiration, as if it has stopped for 2-5 minutes, then brain death is a consequence. If the patient is not breathing you have to interfere immediately and possibly perform a tracheostomy, an opening in the trachea, or if you are in the emergency room you may put nasolaryngeal tube (endotracheal tube), a tube in the trachea between true vocal cords for the respiration to continue, if it was above the vocal cords it may cause adduction and suffocation.

2. **Regulation of blood pH**
   Gases in the blood, the amount of oxygen and CO2 are always measured in arterial blood during normal gas analysis, hence the name “Arterial Blood Gases” not venous.
3. **Filters the inspired air**

   The vestibule of the nose is the first structure to filter the air from dust, foreign bodies, viruses, and bacteria, the vestibule contains short, thick hair called vibrissae and are present on the anterior part of the nose.
4. **Olfaction, Smell**

   The roof of the nose contains bipolar cells for smell sensation. And there are filaments of olfactory nerve (the first cranial nerve) starting from the roof of the nose and end in the smell center which retrieves this smell “translates the smell to find out the source”.
5. **Phonation, Sound production**

   Larynx contains true vocal cords which are responsible for voice production upon vibration.

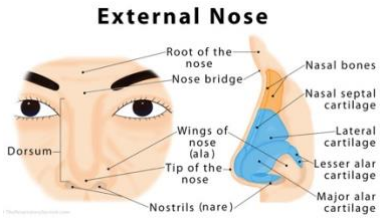
   Phonation = speech
6. **Mucous Secretion**

   Histological layers of respiratory tract:

   a. Mucosa
   b. Submucosa: responsible for secretion and filtration of dust and foreign bodies and moisturizing of air
   c. Supportive layer “cartilage (Hyaline in Trachea) or smooth muscle (Bronchioles, no cartilage)”
   d. Adventitia

7. **Excretes small amounts of water and heat.**

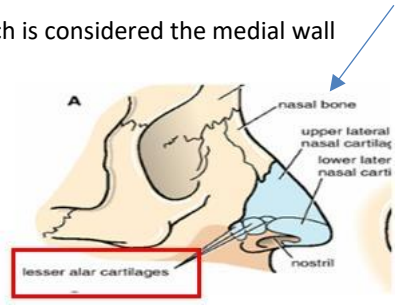
Nose



The Nose is mainly divided to:

1) External Nose: Anterior 2/3 movable and is made out of cartilage
2) Internal Nose (Nasal Cavity).

→ The nose can be generally described as two cavities separated by a septum, which is considered the medial wall of the nose.



1-External Nose
Has 2 main parts: Cartilaginous framework and bony.

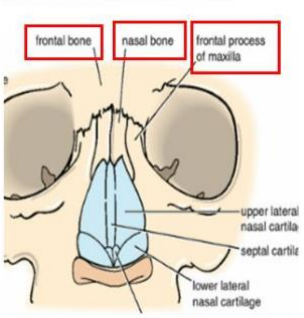
Cartilage Framework:
1. Septal cartilage (middle wall):
   a. Anteriorly by cartilage
   b. Above, vertical plate of ethmoid
   c. Posteriorly and downwards: vomer

2. Lateral nasal cartilage (lateral wall):

a. Upper lateral cartilage
b. Lower lateral cartilage

3. Alar cartilage
Covered by muscles, naris compressor muscle and naris dilator muscle.
These muscles are the reason why rabbits and some humans have the ability to move their alas.

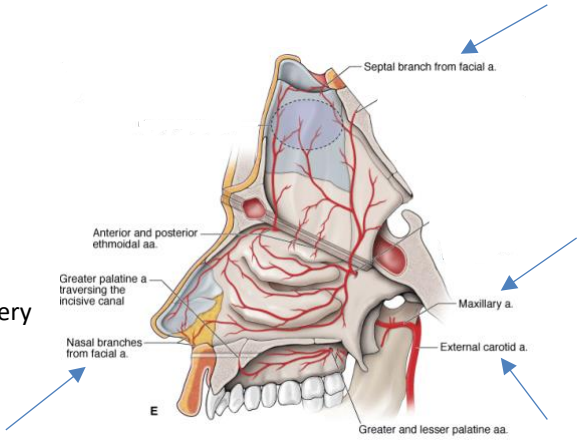
Note that the anterior 2/3 of the nose is made by the above cartilage, and it's movable.



Bony framework of the external nose:

1. The nasal bone
2. Frontal process of maxilla. Superior to it is the maxillary process of frontal bone
3. Nasal part of frontal bone

The External Nose **Blood Supply**



Rule:

1. Upper jaw and the upper part of the face get their blood supply from the maxillary artery.
2. The lower mandible gets its blood supply from the maxillary artery and nerve supply from mandibular nerve.

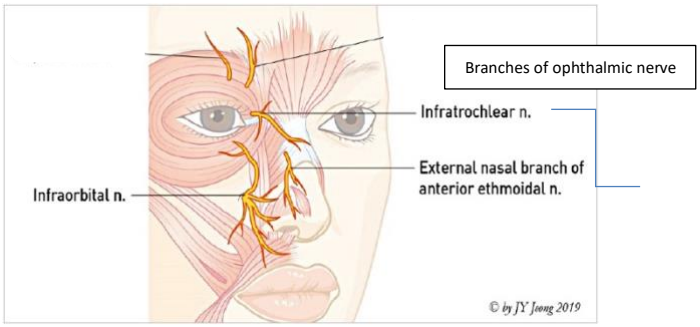
The External nose blood supply is provided by:

1. The ophthalmic artery: branch of the internal carotid artery from inside the skull.
   The ophthalmic artery travels through the orbital cavity through the optic canal, while accompanying the optic nerve.

2. The maxillary artery which branches off in the parotid gland as a termination of the external carotid artery which gives superficial temporal and maxillary artery supplying the face.
   Gives blood supply to the upper jaw and then enters the inferior orbital foramen to become the infraorbital artery.

3. The facial artery branch from external carotid artery going to the face
   Also participates in the blood supply to the external nose. The facial artery gives rise to the upper/superior labial artery which gives rise to the nasal artery. The fascial artery supplies the ala and the lower part of the septum.

External Nose Nerve supply:



- The External nose is supplied by:

1-Branches of the ophthalmic nerve:
Infratrochlear and External nasal (continuation of the anterior ethmoidal)

2-Infraorbital branch of the maxillary nerve, the maxillary nerve gives the infraorbital branch when traveling through the inferior orbital foramen.

Nasal Cavities

We have mentioned earlier that we have 2 cavities separated by a septum composed of cartilage, perpendicular plate of ethmoid and vomer.

1-Begins and Extends from the anterior nasal opening/aperture (nostril/anterior nares)

Above it is the vestibule which is inside the nostril / ala of the nose
Histology of the vestibule is pseudostratified squamous keratinized with hair follicles (vibrissae) → similar to skin.

To the posterior nasal apertures (choana/posterior nares).

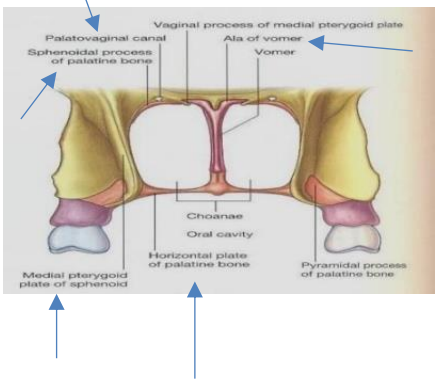
An exception to the histology of the respiratory tract is the vestibule and the roof (bipolar). If the doctor asked about the histology of the respiratory tract, we say that it is pseudostratified ciliated columnar epithelium

- Nostril

The anterior nares of the nasal cavity from which air comes in. Held open by the surrounding alar cartilage and septal cartilage. Can be widened further by the action of the related muscles of facial expression.

- Choana

The posterior nares of the nasal cavity, it connects the nasal cavity with the nasopharynx, divided by the vomer (nasal septum) which has a process called the ala of vomer.



Boundaries of the choana are:

1- Medially→ the vomer and the vomer has a superior process called ala of vomer.

2- Anteriorly and inferiorly → horizontal plate of palatine bone

3- Laterally →Medial pterygoid plate

4- Roof → 1. palatovaginal canal (foramina) which leads to the nasopharynx.

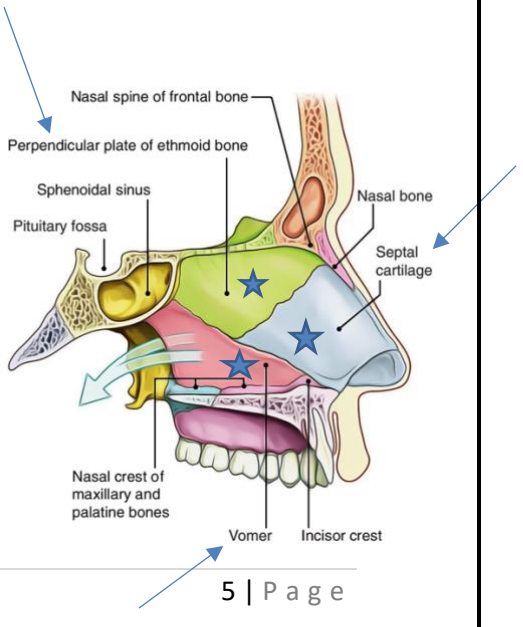
2.sphenoidal process of palatine bone

2-Bounded by medial wall, lateral wall, roof and floor:

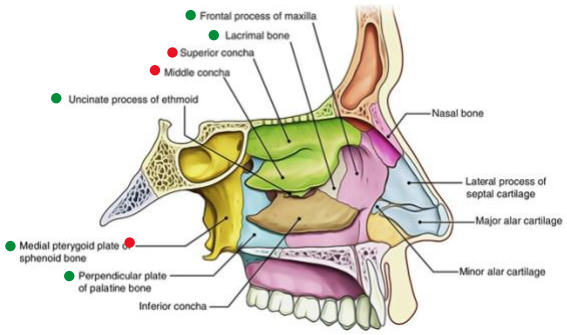
1. The medial wall (nasal septum):

It is located in the middle dividing the nasal cavity into 2 cavities, it is made of:

1. Septal cartilage "anteriorly"
2. Vomer
3. Perpendicular plate of ethmoid bone "Posteriorly"



2. Parts of the lateral wall

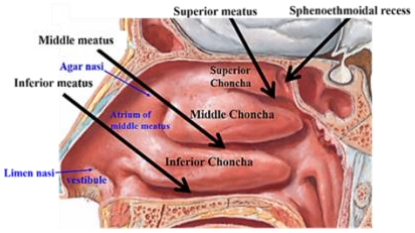


Lateral wall of the nasal cavity has thick mucosa which has venous plexus of blood responsible for warming and moistening of air.

1) Nares which is the opening

1) Vestibule:
It is the area of the nasal cavity lying just above the nostril in the ala of the nose, its feature is that the mucosa is stratified squamous keratinized and contains hair follicles called <u>vibrissae → identicle histology of the skin</u>

2) 3 Conchae's and 3 meatuses and 1 recess:



*The conchae

It is a bulge of bone which is covered with mucosa, it functions to increase the surface area of the nasal cavity.

There are <u>three conchaes</u> on the lateral wall of the nasal cavity:
-Superior and Middle → ethmoidal bone
-Inferior (separated) → Maxillary

All Choncae extend medially across the nasal cavity, separating it into four air channels: 3 meatuses and one Sphenoethmoidal recess

<u>Bony support of the lateral wall:</u>

Lateral wall of the nasal cavity is full of bones

1. Ethmoidal labyrinth and uncinated process
2. Perpendicular plate of the palatine bone
3. Medial plate of the pterygoid process
4. Medial surfaces of the lacrimal bones and maxillae
5. Inferior concha of maxilla

*The meatus

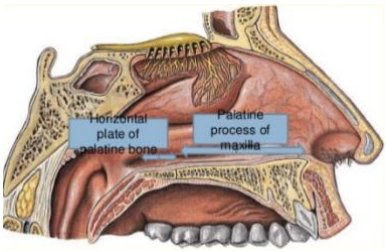
Which is a groove that is located below a conchae "groove below the bulge" the conchae is a shelf and below it a groove called meatus, which in it opens the paranasal sinuses.

There are three meatuses on the lateral wall of the nasal cavity, each meatus below a choncae:

-Superior meatus -Middle meatus. -Inferior meatus

*The recess of the lateral wall of the nasal cavity
It is called spheno-ethmoidal recess, it's the recess in which sphenoid sinus open into the lateral wall of nasal cavity. And it drains the sphenoidal air sinus.
Drainage means allowing a passage pathway for the secretions of the sphenoidal air sinus if it got inflamed.

3. Floor of Nasal Cavity



Upper surface Hard Palate

a. Palatine process of maxilla
b. Horizontal plate of palatine bone
c.

4. Roof of Nasal Cavity

a. Anterior part •

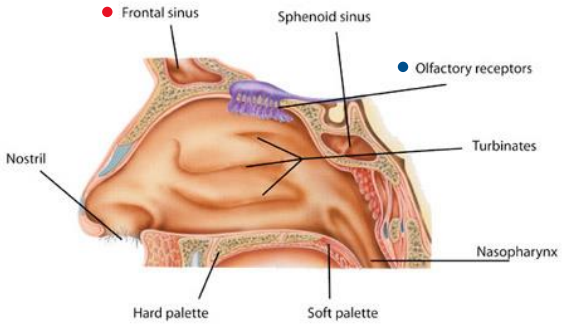
Made of Nasal spine of the frontal bone and the nasal bone.

b. Middle part •

horizonal cribriform of ethmoid for filament of olfactory nerve (bipolar cells)
Olfactory bulb which has accumulations of filaments → olfactory tract → center of smell

c. Posterior part

1-Anterior surface of the sphenoid bone (body) and sphenoidal sinus
2-Ala of the vomer
3-Vaginal process of the palatine bone



Again, functions of the nasal cavity:

1. Respiratory
2. Olfactory
3. Resonance of voice → responsible for the uniqueness of the voice due to the presence of the air sinuses which are air sinuses inside the skull bones (frontal, maxillary, ethmoidal, sphenoidal), and covered by mucosa. Each air sinus duct open in the lateral wall of the nose, and so if a person had sinusitis, which is an inflammation of the sinuses, causes voice change, this is why we will find a greenish secretion (originally water) due to inflammation.
4. Drains lacrimal fluid → inferior meatus has an opening for the nasolacrimalk duct which starts at the medial side of the eye which is a bag filled with tears. When a person shed tears, some of them fall of their cheek and mostly fall into the lacrimal sac which then drains into the inferior meatus, which causes runny nose when crying.
   A birth malformation is a blocked naso-lacrimal duct, at any point of the duct, we will observe tears accumulated and produced from the skin causing inflammation, and it should be drained.
5. Protective
   a. sneezing
   b. Filtration
   c. Proteolytic enzymes
   d. Warming and moisturizing of the skin

Mucous membrane of Nasal Cavity

The respiratory mucous membrane is lined with pseudostratified ciliated columnar epithelium with goblet cells, except for 2 nasal structures:

1-The vestibule, which is lined with stratified squamous keratinized epithelium with hair follicles "vibrissa".

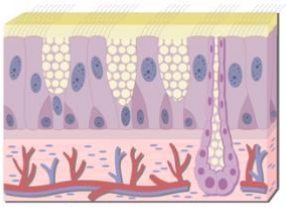
2-The roof which has bipolar cells which is called olfactory mucosa and contains olfactory nerve endings

-Note that the mucous membrane is very thick around the conchae, that is the reason behind the feeling of nose obstruction in the case of rhinitis (inflammation in the mucosa of the nose), specially during winter season, the mucosa becomes extremely thick.

Functions of the mucus membrane:

1-Warming/Heating and moisturizing air, this occurs due to the large number of veins plexuses in the submucosa.

2- Mucous traps foreign particles and organisms in the inspired air


Respiratory (nasal) mucosa

Drainage openings of paranasal sinuses and nasolacrimal duct into the lateral wall of nasal cavity:

1) The sphenoidal air sinus opens into sphenoethmoidal recess

2) The nasolacrimal duct opens into the inferior meatus

3)The ethmoidal sinuses:

There are 3 ethmoidal sinuses on each side, meaning they are 6 in total, their drainage openings are:

*The anterior ethmoidal sinus opens in the anterior part of hiatus semilunaris

* The middle ethmoidal sinus opens in the middle meatus in a bulge called bulla ethmoidalis which contains the sinus and the opening of the sinus.

*The posterior ethmoidal sinus opens in the superior meatus

4) The maxillary air sinus opens in the middle meatus into the infero-posterior part of hiatus semilunaris

5) The frontal air sinus opens into the middle meatus through the infundibulum and frontonasal duct

Note: Infundibulm is located anterior to hiatus semilunaris. So frontal drains in the infundibulm which is anterior to hiatus semilunaris. Anterior ethmoidal drains into the anterior part of hiatus semilunaris. "important"
Hiatus semilunaris is a groove which has ethmoidal bulla which is a bulge in the middle meatus

All of the air sinuses have good drainage except the maxillary, a good drainage means even if there is an infection the secretion will flow down easily to the nose through drainage openings. Except for the maxillary sinus since the maxillary drainage opening is high up in the inferoposterior part of hiatus semilunaris, and so doesn't drainage unless the person bows down, which is why if a person has an inflammation and bows down, he will feel throbbing pain.

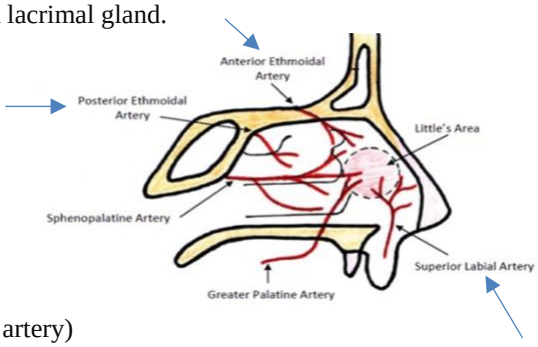
Blood and Nerve supply of the Nasal Cavity

When discussing the blood or nerve supply of the nose, we divide it into two major categories:
Vessels and nerves that supply the septum and vessels and nerves that supply the lateral wall.

The Maxillary artery sphenopalatine fossa gives off 2 branches: palatine (greater and lesser) and sphenopalatine (long and short)

1. Sphenopalatine artery
   originates from maxillary artery in pterygopalatine fossa, which is very important because it has accumulation of nerve and blood supply for the nose, nasopharynx, orbit and lacrimal gland.

   a. Long sphenopalatine Artery:
      More important



Goes to lateral wall of the nose which gives off:

   a. Anterior ethmoidal artery
   b. Posterior ethmoidal artery
      (branches of the internal carotid artery → ophthalmic artery)

   Anteriorly

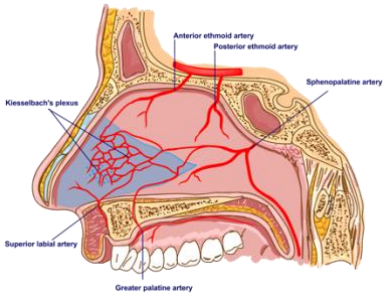
   a. Superior labial artery (facial artery)
   b. Superior alveolar artery (infraorbital artery)

All those arteries supply the lateral wall of the nasal cavity.

Some books divide lateral wall into 4 quadrants: upper and lower posterior, and upper and lower anterior.

Upper lateral → short sphenopalatine artery

And the rest → long sphenopalatine artery



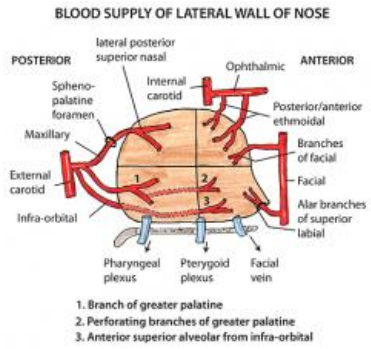
Septum:

Again, Long sphenopalatine artery

Branches of the maxillary artery:

1. Greater palatine → hard palate through the greater palatine foramen and goes back to the lower part of the nose to supply the lateral wall
2. Lesser palatine → soft palate

Anterior ethmoidal → septal branch



Epistaxis

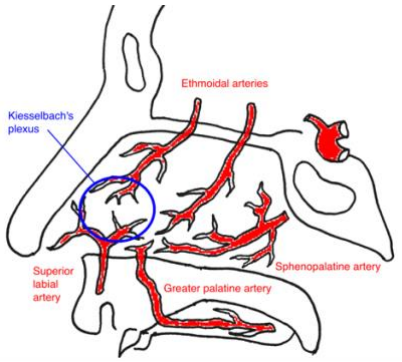
Bleeding of the nose

Common in children

Occurs mostly in the anastomosis in the septum anteriorly called Kiesselbach's area which is an accumulation of arteries

Arteries that should be uterized:

1. Long sphenopalatine → from sphenopalatine → maxillary
2. Superior labial artery → from facial



Venous drainage

1. Anterior 1/3 → Facial vein

2. Posterior 2/3 → Maxillary vein to the lateral pterygoid plexus around the lateral pterygoid muscle

Maxillary veins go to the parotid gland which meets the superficial temporal vein to form the retromandibular vein

Lymphatic drainage

- Anterior part → submandibular lymph nodes
- Upper and posterior → retropharyngeal/upper deep lymph nodes **then** to the deep cervical nodes which are around the internal carotid vein.

Innervation of the nose

1. Olfactory (bipolar cells) on the roof for smell sensation which proceed as olfactory filament → bulb → tract
2. Ophthalmic and maxillary → general sensation
3. Facial Nerve → parasympathetic, secretomotor to the mucos gland of the nose

Olfactory nerve has filaments that interfere through the cribriform to form the bulb and then the tract

Anterior-posterior ethmoidal nerve → come from the nasociliary nerve inside the eye and are sensory supply for the lateral wall, septum and anterior wall

Posterior is for the air sinuses

Maxillary nerve → innervation is similar to the artery in name.