Pranayama

Teachers Training Level 1

Level 1 2023

Anatomy & Physiology
Class 2
Inspiration & Expiration

Yoga Education Collective

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श्री गुरुभ्यो नमः हरिः ॐ

Om Om Om

Sri Gurubhyo Namah Harih Om

Salutations to the Gurus!

ॐ सह नाववतु ।
सह नौ भुनक्तु ।
सह वीर्यं करवावहै ।
तेजस्वि नावधीतमस्तु मा विद्विषावहै ।
ॐ शान्तिः शान्तिः शान्तिः ॥

oṃ saha nāvavatu saha nau bhunaktu
saha vīryaṃ karavāvahai
tejasvi nāvadhītamastu mā vidviṣāvahai
oṃ śāntiḥ śāntiḥ śāntiḥ

May that Brahman protect us together. May it nourish us together. May we both gain great vitality. May our learning be brilliant. May we never argue. Om peace, peace, peace.

From “The Science of Pranayama” by Swami Sivananda

‘Svasa’ means inspiratory breath and ‘Prasvasa’ is expiratory breath. Breath is external manifestation of Prana, the vital force. Breath like electricity, is gross Prana. Breath is Sthula, gross. Prana is Sukshma, subtle.

By exercising control over this breathing you can control the subtle Prana inside. Control of Prana means control of mind.

It is Prana that moves the mind. It is Prana that sets the mind in motion. It is the Sukshma Prana that is intimately connected with the mind.

This breath represents the important fly-wheel of an engine. If you can control the fly-wheel, you can easily control the other wheels. Likewise, if you can control the external breath, you can easily control the inner vital force, Prana. The process by which the Prana is controlled by regulation of external breath, is termed Pranayama.

Mechanics of Breathing: Inspiration & Expiration

Inspiration and **Expiration**

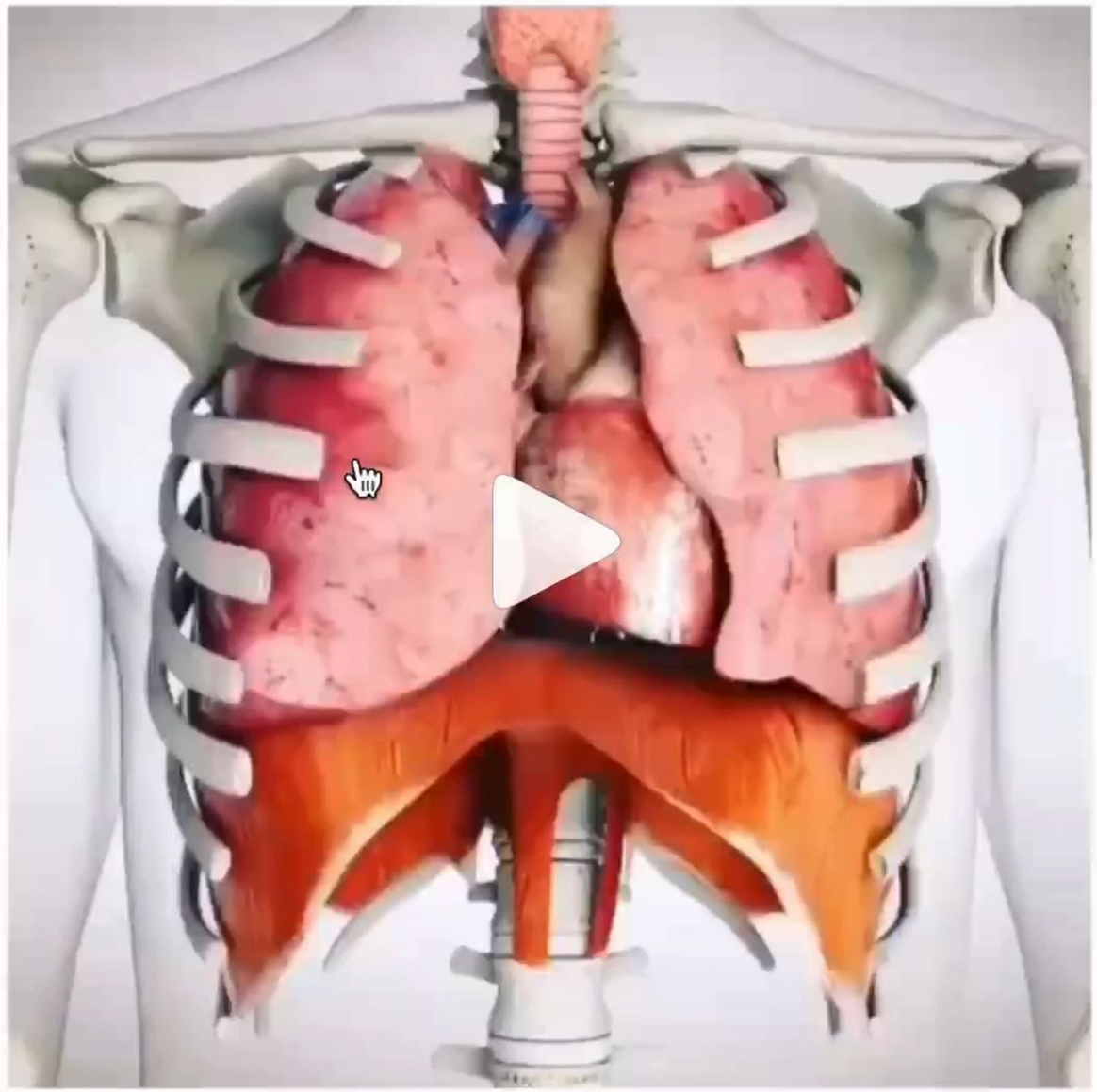
are “scientific” terms for

Inhalation and **Exhalation**

Five things are necessary for practising Pranayama

1. A good place
2. A suitable time
3. Moderate, substantial, light and nutritious food
4. Patient and persistent practice with zeal, ease and earnestness
5. Purification of Nadis

“The Science of Pranayama” Swami Sivananda



INSTINCTIVE BREATHING

The aim of respiration is to maintain the necessary blood levels of oxygen and carbon dioxide for the corresponding level of activity. The trigger to breathe, as well as breathing itself, is subconscious, but the rate and force of breathing can be consciously modified.

RESPIRATORY DRIVE

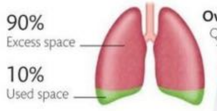
Oxygen is vital for cells to function, yet the drive to breathe is mainly determined by levels of carbon dioxide in the blood. Hemoglobin, the oxygen-carrying molecule (see p.341), has a built-in reserve, and can continue to donate oxygen to cells even when blood levels of oxygen are low. However, carbon dioxide readily dissolves in plasma and is converted to carbonic acid, which quickly damages the cells' ability to function properly. Therefore, breathing is triggered by rising levels of carbon dioxide or acid, and only very low oxygen levels stimulate breathing.

Specialized cells called chemoreceptors measure blood levels and send nerve impulses to the respiratory center of the brain stem within the medulla oblongata. Corresponding messages from the brain then activate the respiratory muscles.

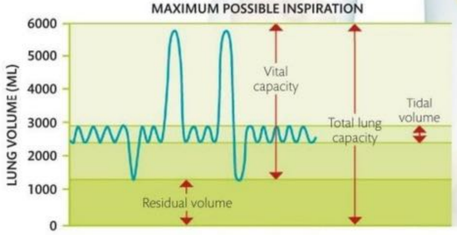
PATTERNS OF BREATHING

During normal breathing, only 18 fl oz (500 ml) of air flows into and out of the lungs. This is known as the tidal volume. The lungs have extra, reserve capacity (the vital capacity) for both inhalation and exhalation so that they can increase the amount of air they take in during exercise.

The maximum amount of air that the lungs are able to hold is around 204 fl oz (5,800 ml), but about 35 fl oz (1,000 ml) of this remains within the respiratory passages after each out breath. This is called the residual volume and cannot be displaced voluntarily.



Overbuilt
Quiet breathing uses less than 10 percent of the total lung capacity. These huge reserve volumes enable a person with one lung to survive.

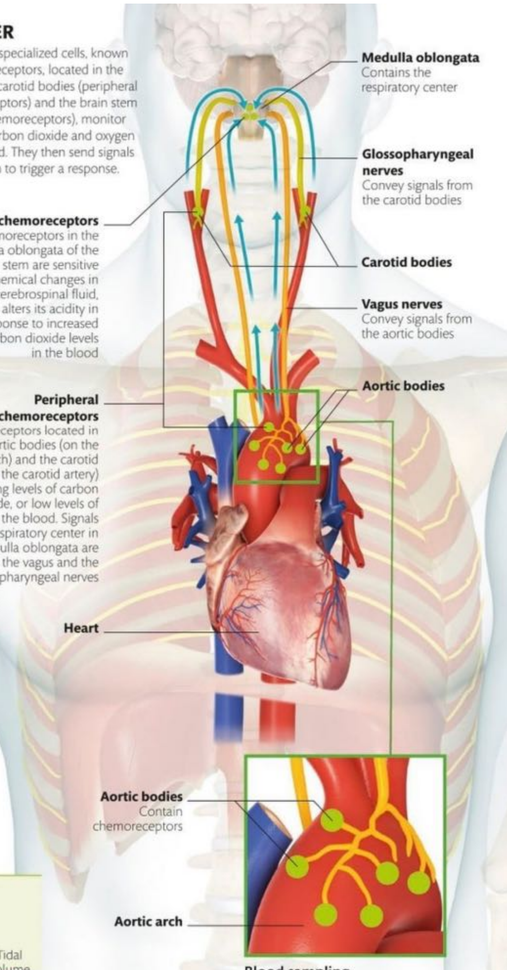


TRIGGER

Clusters of specialized cells, known as chemoreceptors, located in the aortic and carotid bodies (peripheral chemoreceptors) and the brain stem (central chemoreceptors), monitor levels of carbon dioxide and oxygen in the blood. They then send signals to the brain to trigger a response.

Central chemoreceptors
Chemoreceptors in the medulla oblongata of the brain stem are sensitive to chemical changes in the cerebrospinal fluid, which alters its acidity in response to increased carbon dioxide levels in the blood

Peripheral chemoreceptors
Chemoreceptors located in the aortic bodies (on the aortic arch) and the carotid bodies (on the carotid artery) detect rising levels of carbon dioxide, or low levels of oxygen, in the blood. Signals to the respiratory center in the medulla oblongata are sent via the vagus and the glossopharyngeal nerves



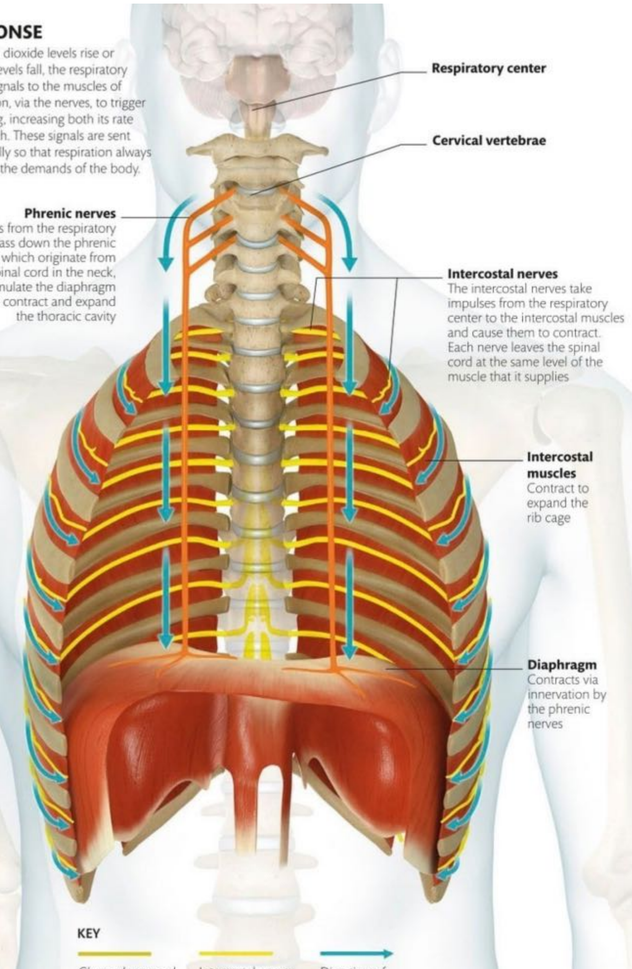
Blood sampling
The aortic bodies are located along the aortic arch. Like the carotid bodies, they have their own blood supply, from which they sample levels of gas and acid.

Spirometer reading
The volume of air held within the lungs is determined by blowing into a machine called a spirometer. The results are recorded as a graph (left).

RESPONSE

If carbon dioxide levels rise or oxygen levels fall, the respiratory center signals to the muscles of respiration, via the nerves, to trigger breathing, increasing both its rate and depth. These signals are sent continually so that respiration always matches the demands of the body.

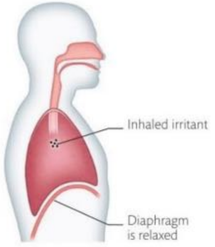
Phrenic nerves
Messages from the respiratory center pass down the phrenic nerves, which originate from the spinal cord in the neck, and stimulate the diaphragm to contract and expand the thoracic cavity



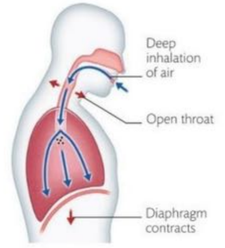
REFLEXES

Inhaled air often contains particles of dust or corrosive chemicals that could damage the surfaces of the lungs and reduce their ability to function. Cough and sneeze reflexes exist to detect and expel such irritants before they reach the alveoli. Nerve endings in the respiratory tract are very sensitive to touch and chemical irritation and, if stimulated, send impulses to the brain to initiate a sequence of events that causes the offending object or chemical to be coughed or sneezed out.

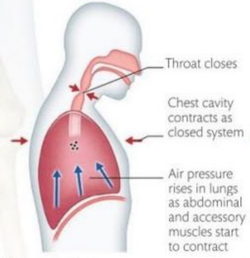
Forcible explusion
Schlieren photography, which registers density changes, reveals the air turbulence from a cough.



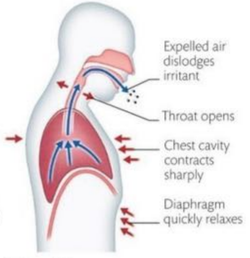
1. Irritation
Inhaled particles or chemicals irritate sensitive nerve endings, which send signals to alert the brain to the intrusion.



2. Inhalation
The brain signals to the respiratory muscles to contract, causing a sudden intake of breath (88 fl oz/2,500 ml).



3. Compression
The vocal cords and the epiglottis shut tightly and the abdominal muscles contract, raising air pressure in the lungs.



4. Expulsion
The epiglottis and vocal cords open suddenly, expelling the air at high velocity and taking the irritant with it.

Divers often **exceed** depths of 328 ft (100 m), which involves them **not breathing** for several minutes at a time.

EXTREME HUMAN
FREE DIVING

Some forms of free diving involve divers competing to go as deep as possible without using breathing apparatus. They train by exercising on land while holding their breath to get their muscles used to working without oxygen. Prior to the dive, some divers hyperventilate in an effort to rid their blood of as much carbon dioxide as possible—high levels would normally tell their brain of the need to stimulate inhalation. This allows them to dive for longer without feeling they need to breathe. However, this is highly dangerous because their cells may run out of oxygen before their brain realizes they need to take a breath. They risk blacking out under water and drowning.

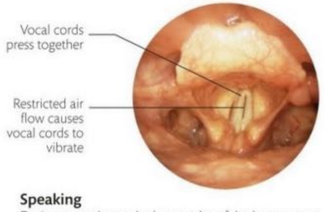
Into the deep
Free diving with fins, or flippers (as shown here), provides extra propulsion and allows divers to reach depths beyond their usual capabilities.

VOCALIZATION

Speech involves a complex interaction between the brain, vocal cords, soft palate, tongue, and lips. When air passes against the vocal cords they vibrate to produce noise. Muscles attaching them to the larynx can move the cords apart for normal breathing, together to create sound, or stretch them to increase pitch. Vibrations are articulated into words by the soft palate, lips, and tongue. Higher air pressure beneath the vocal cords will increase volume. The voice itself finds resonance in the paranasal sinuses (see p.338).

Vocal cords vibrate at a variety of speeds depending on how tightly they are stretched: faster vibrations create high-pitched sound. For example, the vocal cords of a bass singer vibrate at around 60 times per second, whereas those of a soprano can vibrate at up to 2,000 times per second.

Breathing
The vocal cords are held fully open during breathing. Air passes easily between them without causing any vibration and no sound is made.



Speaking
During normal speech, the muscles of the larynx move the vocal cords close together so that air passing through them causes them to vibrate.

Central Nervous System

Midbrain

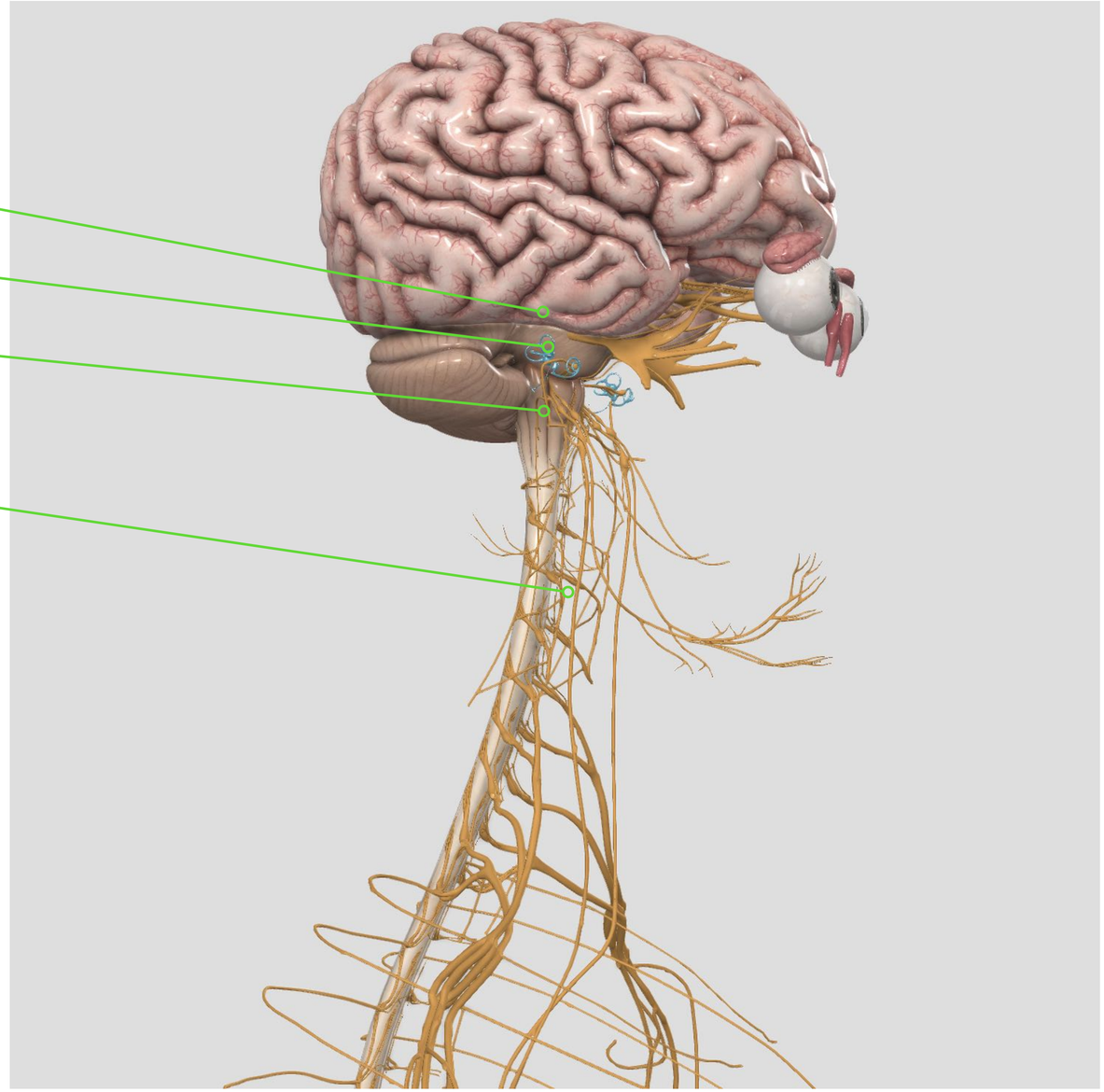
Pons

Medulla

Spinal cord

Respiration is governed by nervous and chemical activity in the body.

First we will discuss the mechanics of air flow in the respiratory system.

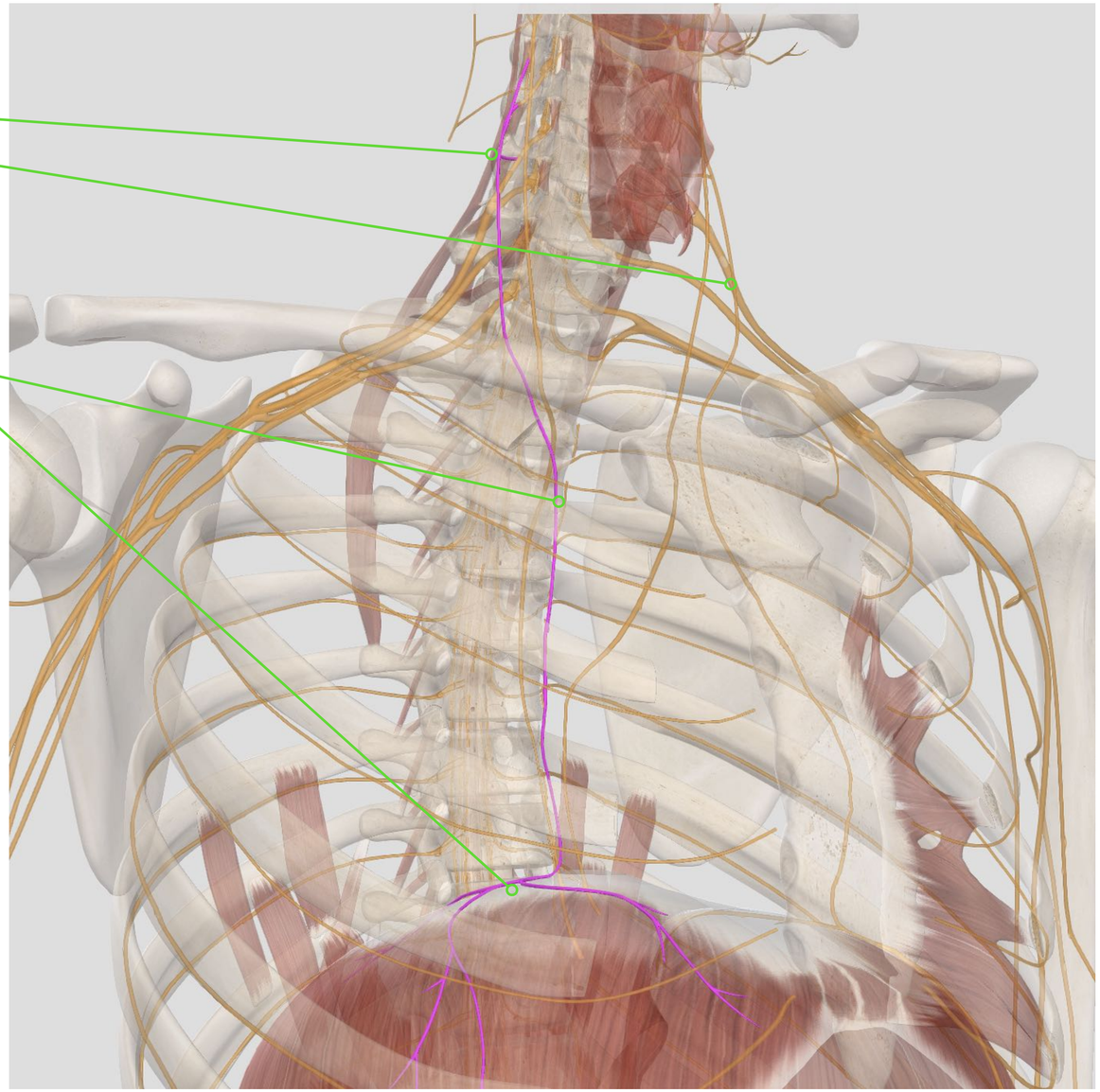


Inspiration - Nerves & Muscles

Phrenic nerves
Right & Left

Mixed motor and sensory nerves which originate from
3rd, 4th & 5th Cervical nerves and enervate the diaphragm.

The Phrenic nerves receive sensory information from the diaphragm and sends motor information to the diaphragm.

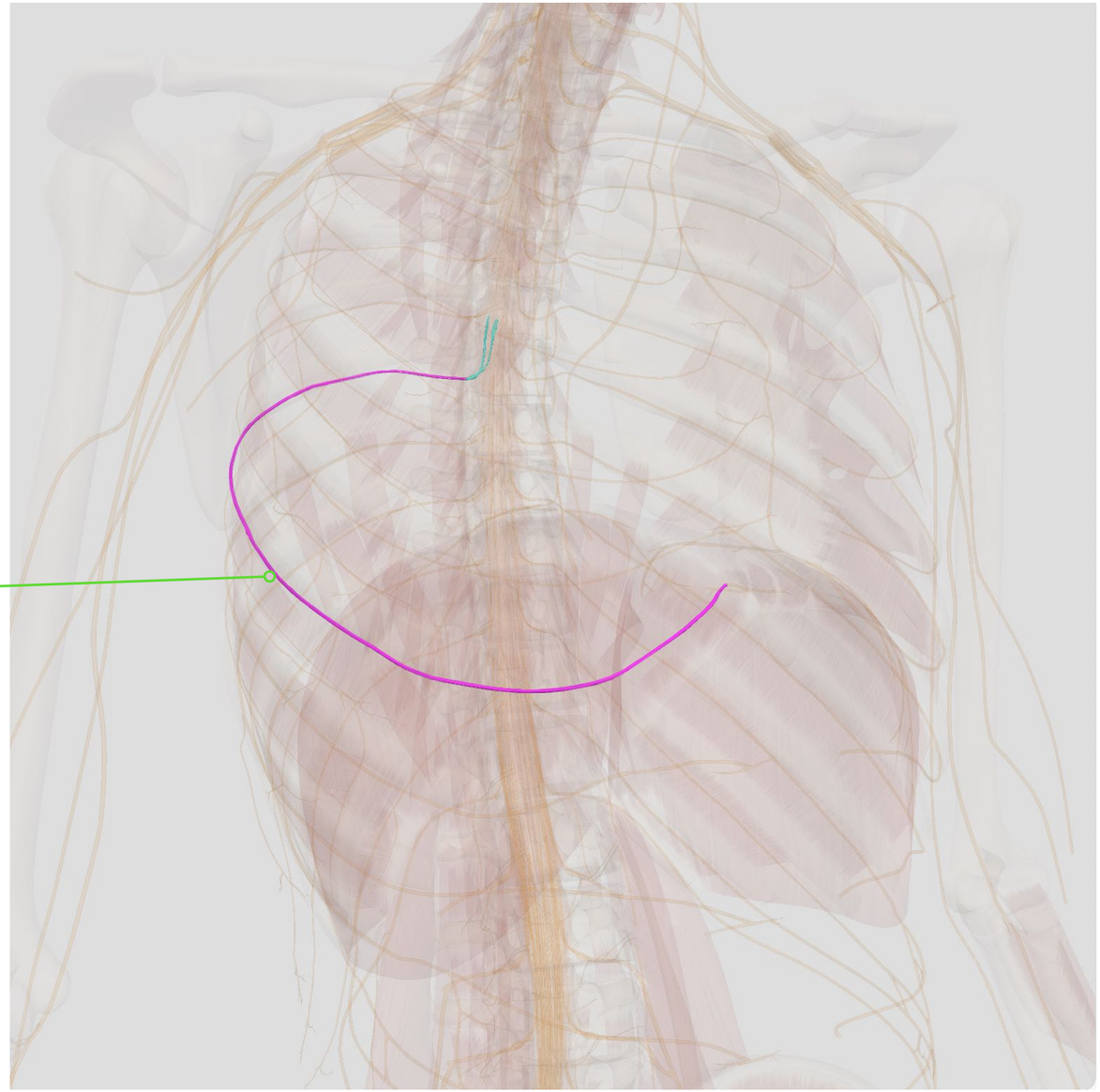


Inspiration - Nerves & Muscles

Intercostal nerves
Right & Left

Part of the Somatic NS
Originate from 1st to 11th Thoracic nerves and enervate the intercostal muscles

The 6th intercostal nerve shown



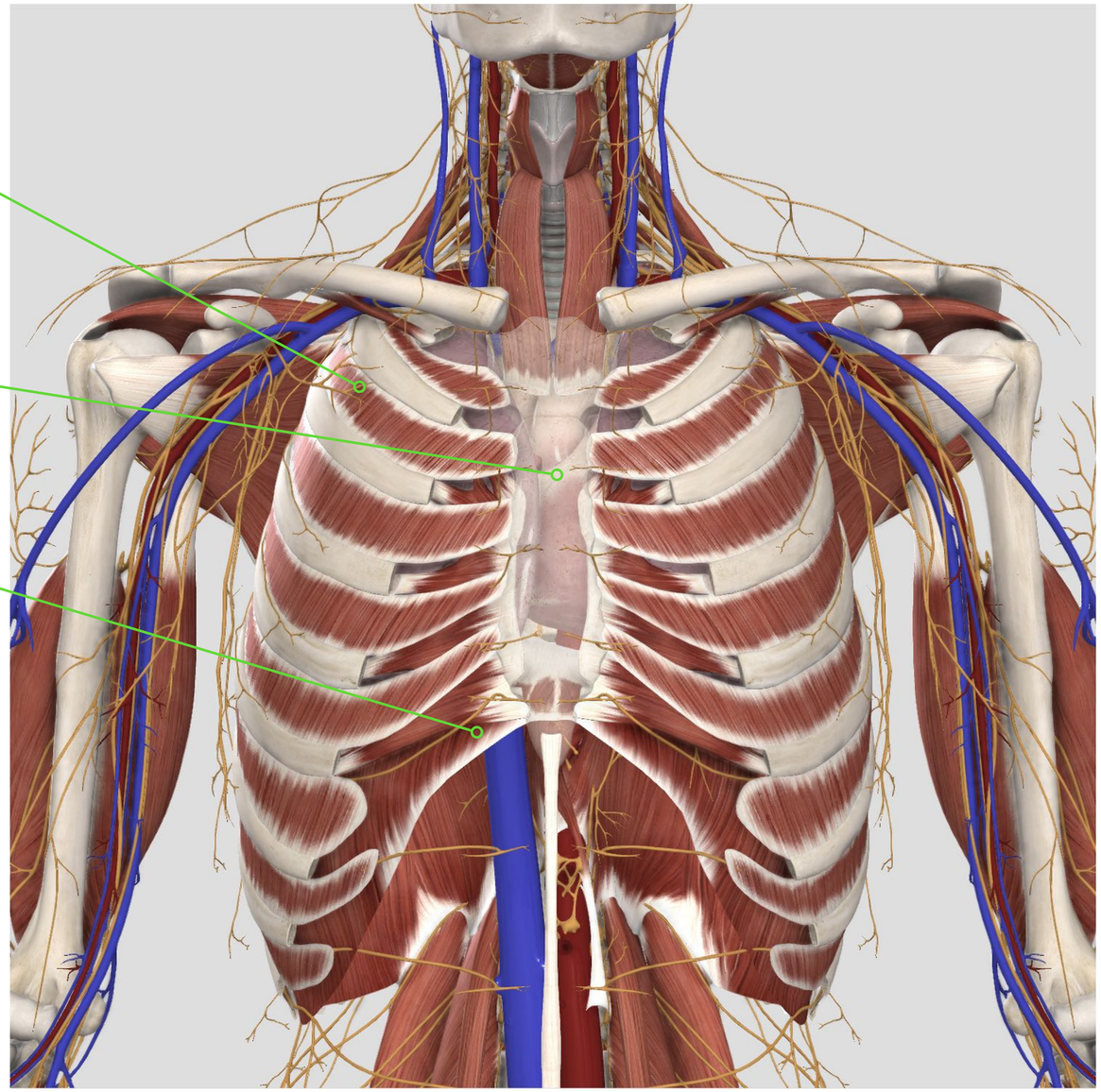
Inspiration - Muscle activity

External and innermost Intercostals lift ribs upwards and outwards 360º around the thoracic cage

Sternocleidomastoids and Scalenes lift the Sternum upwards and forwards

The diaphragm is pulled downwards (360º)

Thoracic cage enlarges and thoracic cavity volume increases thus atmospheric pressure decreases and air moves in to balance according to Boyles Law V↑= P↓

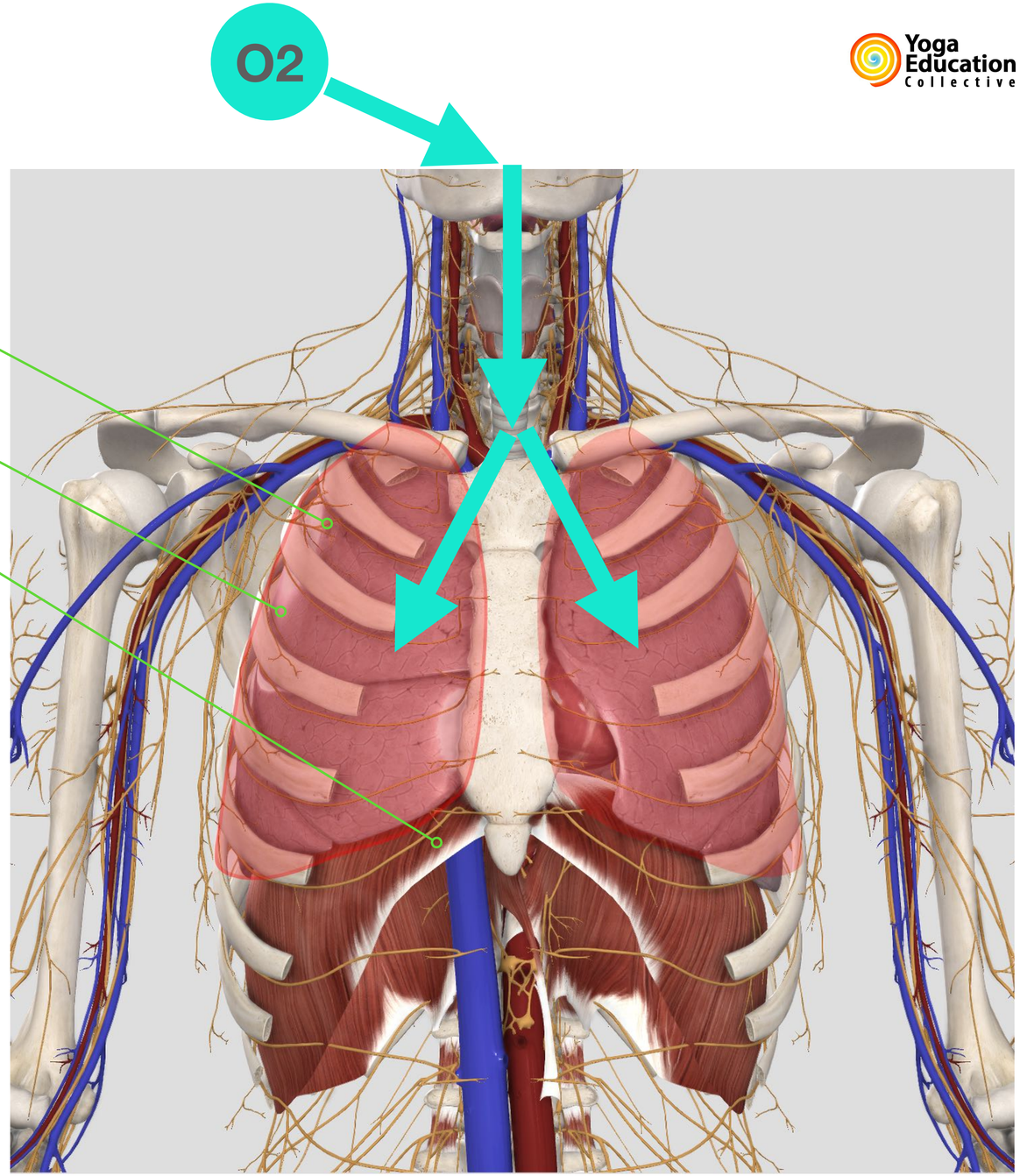


Inspiration - Pressure changes

As the thoracic cavity volume increases it pulls the pleura outwards.

The volume within the lungs increases and the intrapulmonary and intrapleural pressures decrease.

Air will move from high pressure (atmosphere outside the body) to low pressure (inside the alveoli in the lungs) until equal, according to Boyles Law V↑ = P ↓



Expiration - Muscle activity

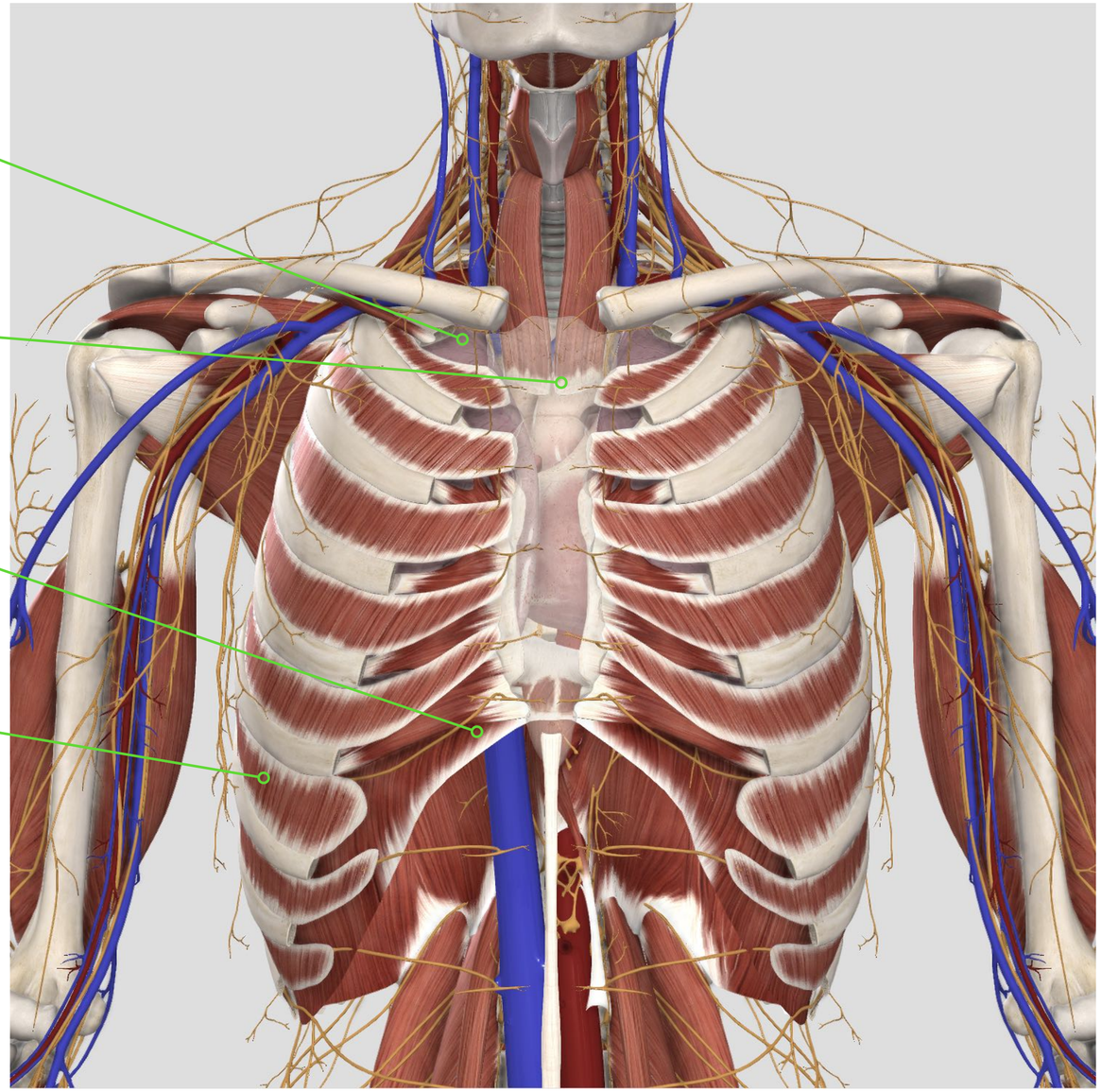
For a quiet expiration the muscles just relax (stretch receptors tell CNS to stop sending signals) and the expiration depends upon the Elasticity (tendency to resist being stretched) of the lungs.

Sternocleidomastoids and Scalenes relax back to their resting positions.

Diaphragm relaxes back to its resting dome- shaped position

For a forced expiration Internal Intercostals lower ribs downwards and inwards 360º around the thoracic cage and abdominal wall muscles (all layers) will also contract

Thoracic cage decreases and thoracic cavity volume decreases, and the elasticity will increase, thus atmospheric pressure increase and air moves out to balance according to Boyles Law V↓ P↑



Expiration - Pressure changes

As the thoracic cavity volume decreases elasticity pulls the pleura inwards.

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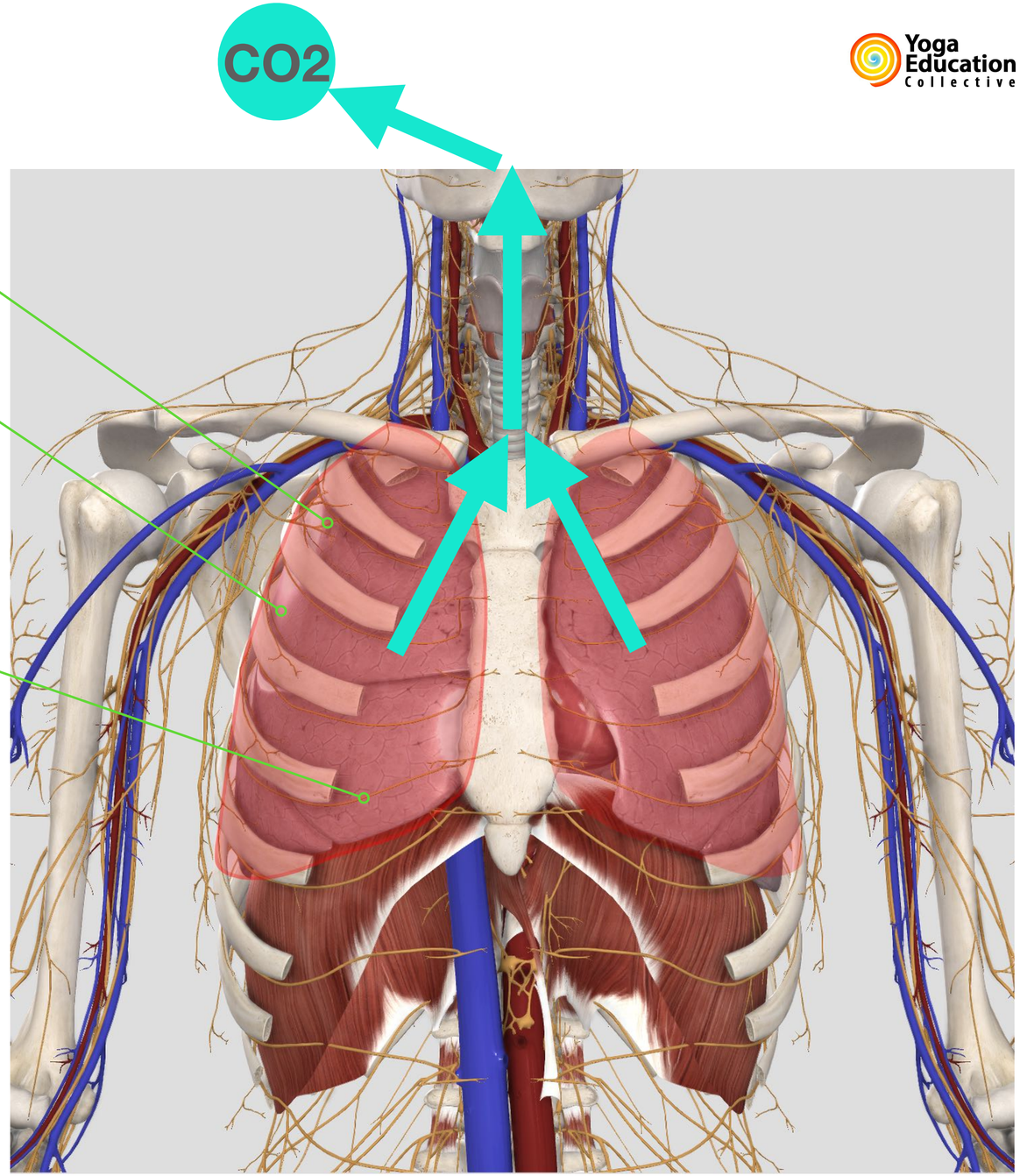
Air will move from high pressure (inside the alveoli in the lungs) to low pressure (atmosphere outside the body) until equal, according to Boyles Law V↓ = P↑



ॐ सर्वे भवन्तु सुखिनः
सर्वे सन्तु निरामयाः ।
सर्वे भद्राणि पश्यन्तु
मा कश्चिद्दुःखभाग्भवेत् ।
ॐ शान्तिः शान्तिः शान्तिः ॥

oṃ sarve bhavantu sukhinaḥ
sarve santu nirāmayāḥ
sarve bhadrāṇi paśyantu
mā kaścid duḥkha bhāgbhavet
oṃ śāntiḥ śāntiḥ śāntiḥ

May all be happy, may all be free from disease, may all see goodness,
may none suffer from sorrow.

ॐ असतो मा सद्गमय ।
तमसो मा ज्योतिर्गमय ।
मृत्योर्मा अमृतं गमय ।
ॐ शान्तिः शान्तिः शान्तिः ॥ हरिः ॐ तत्सत् ॥

asato mā sadgamaya
tamasomā jyotir gamaya
mrityormāāmritam gamaya
Oṁ śhānti śhānti śhāntiḥ harih om tat sat

Lead me from changing existence to unchanging being,
lead me from the darkness of tamas to the light of knowledge,
lead me from death to immortality. Harih om that is truth.