Anaestheasier

Graphical Flashcards

Physiology

For the Primary FRCA

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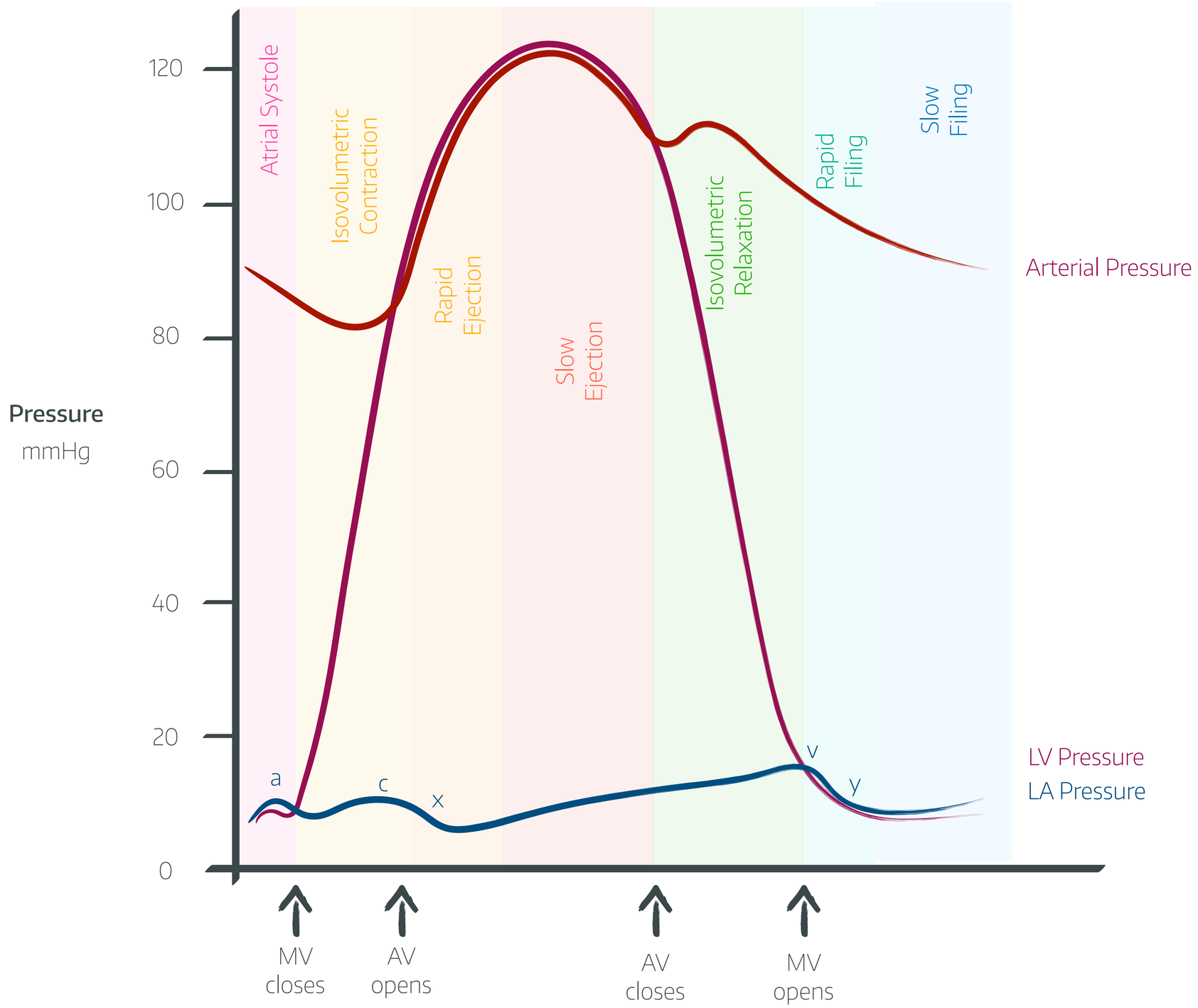
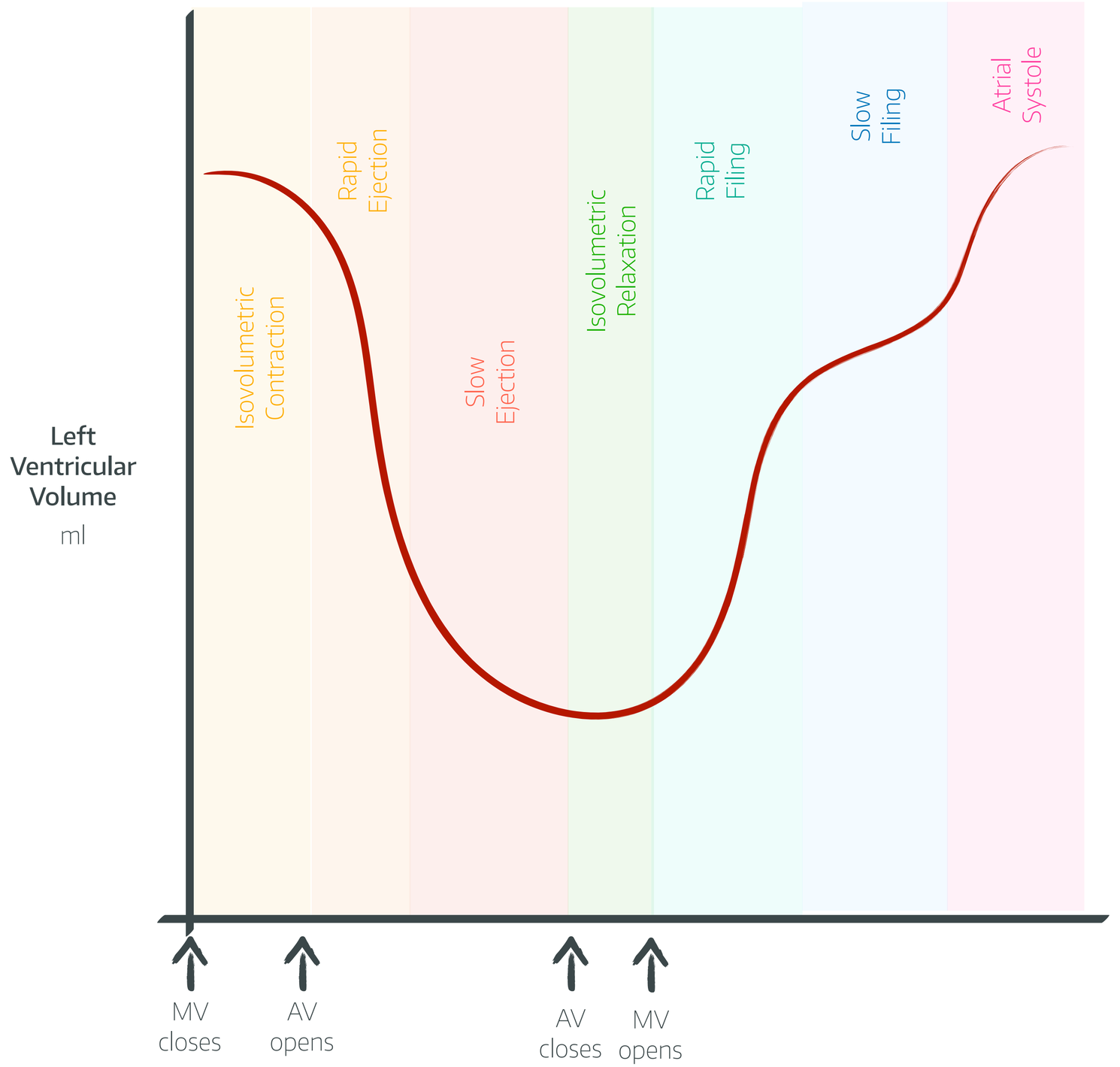
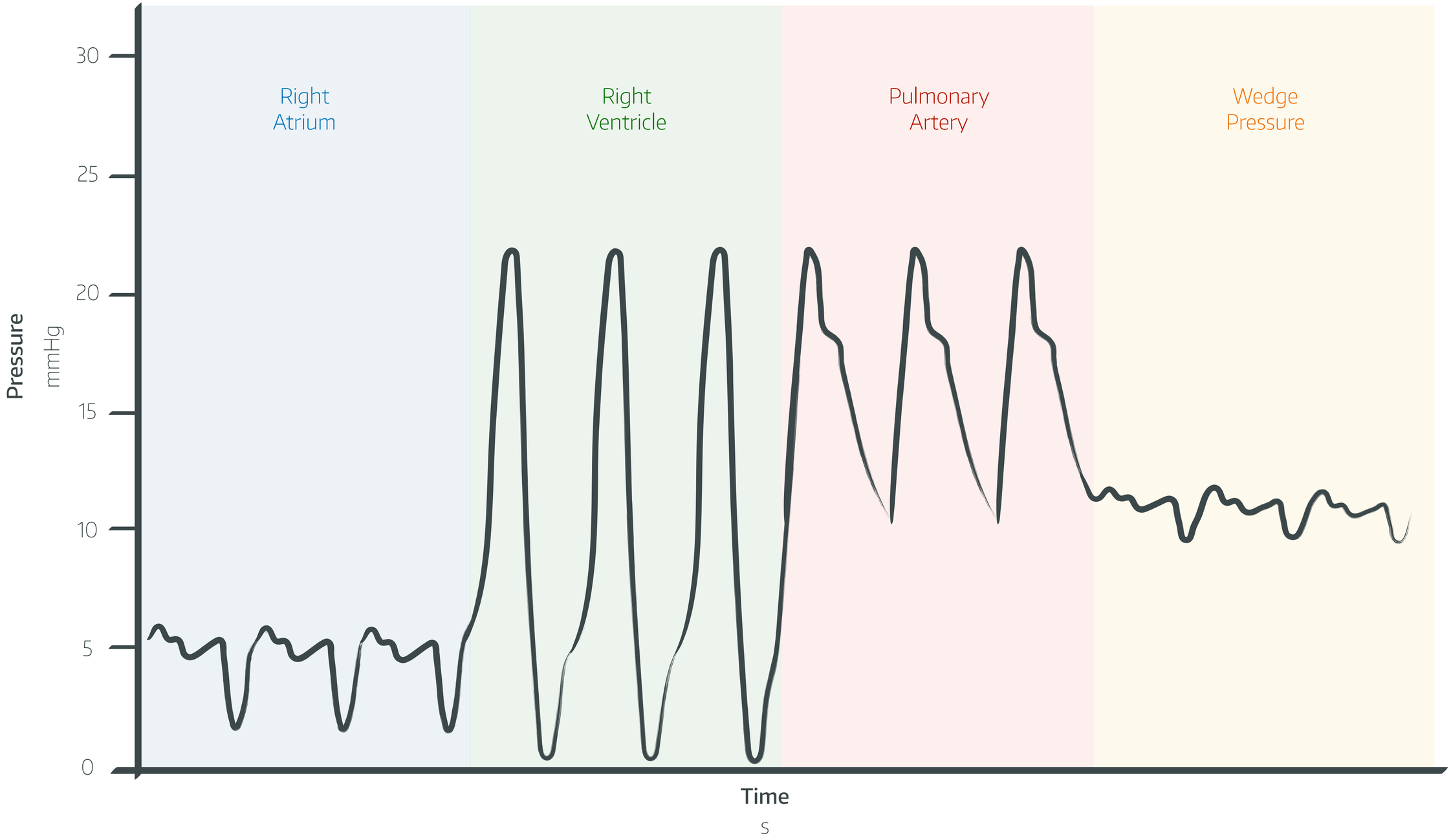
The Cardiac Cycle



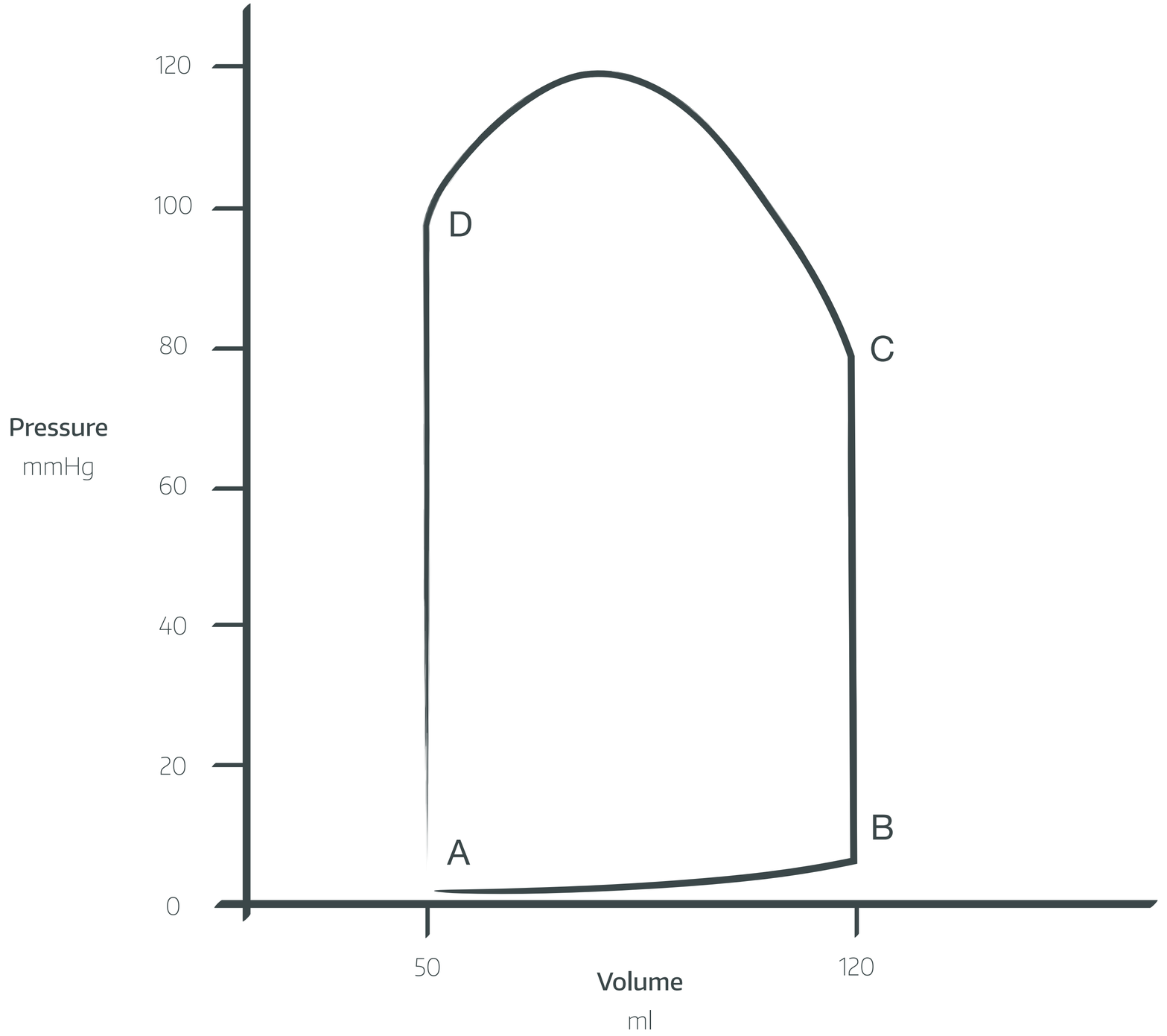
The Cardiac Cycle



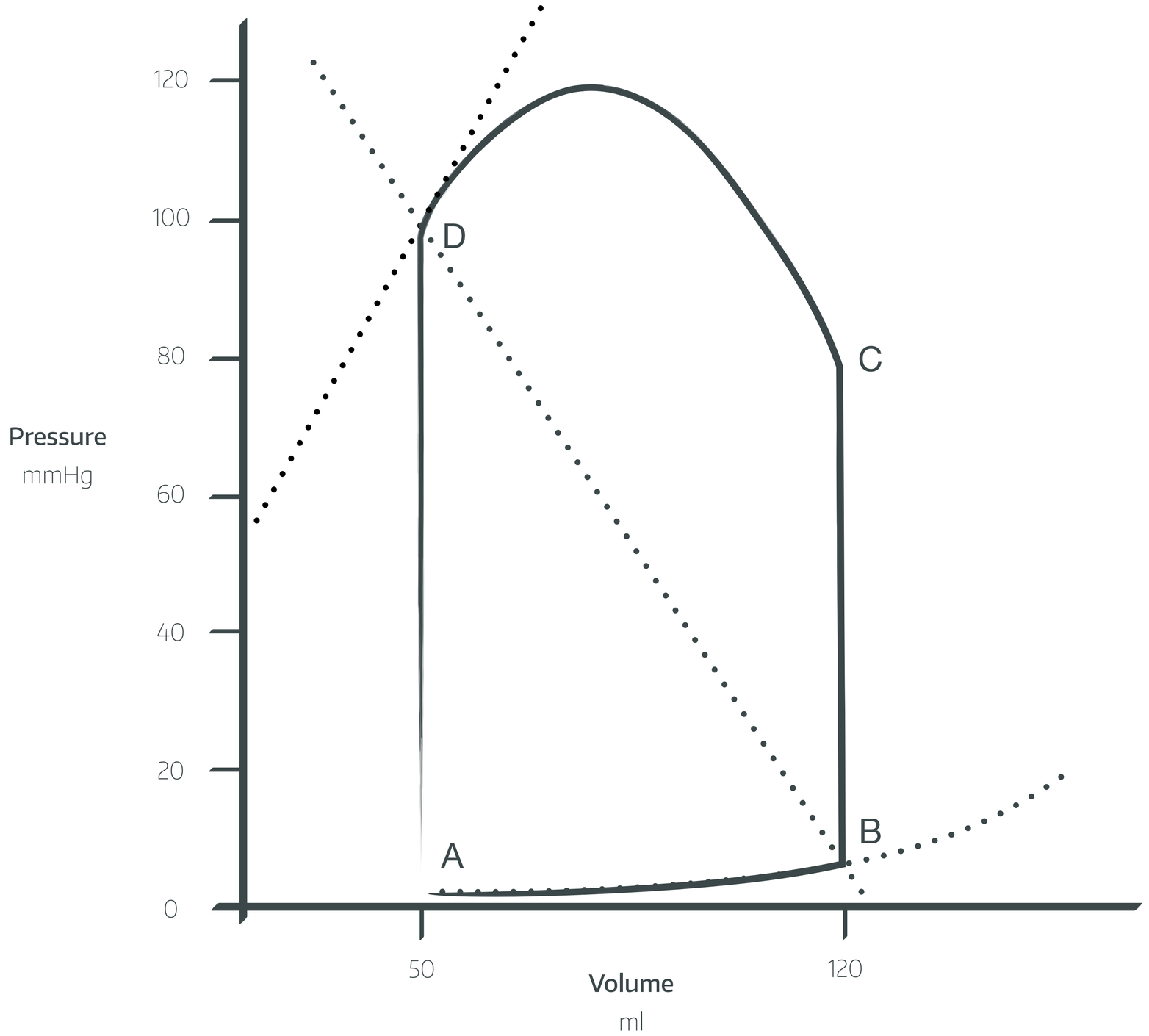
Swan-Ganz Catheter



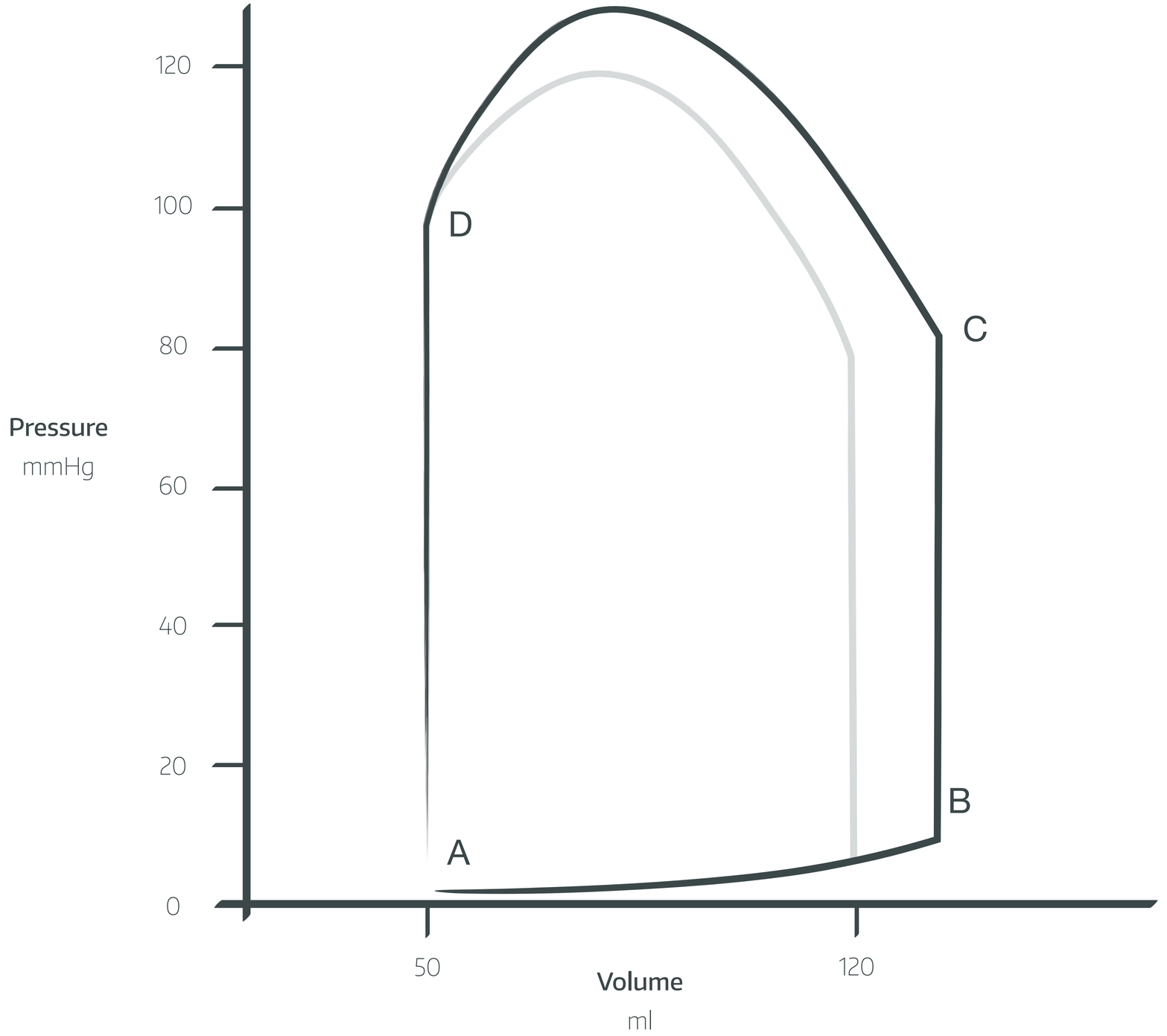
LV Pressure-Volume Loops



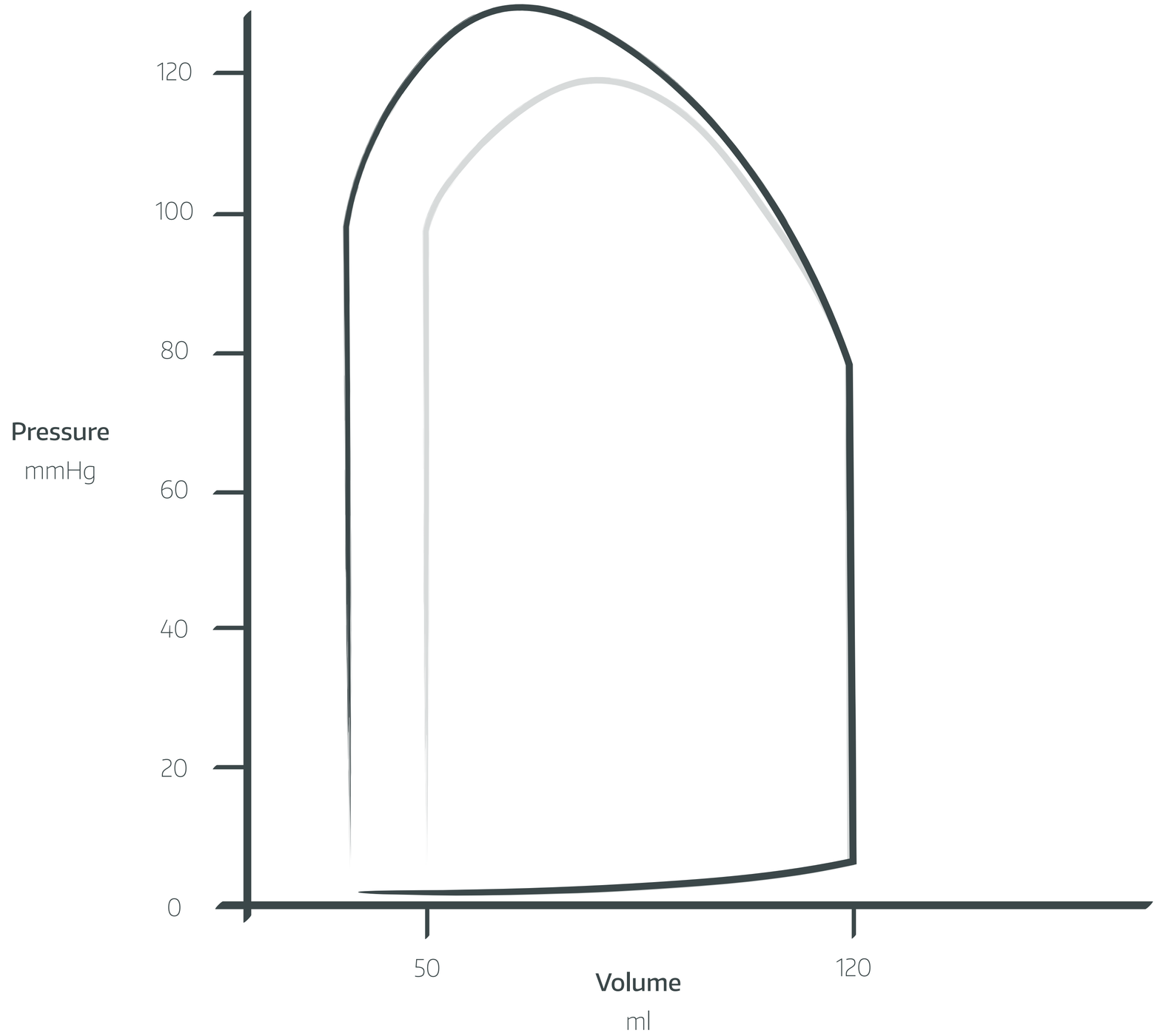
LV Pressure-Volume Loops



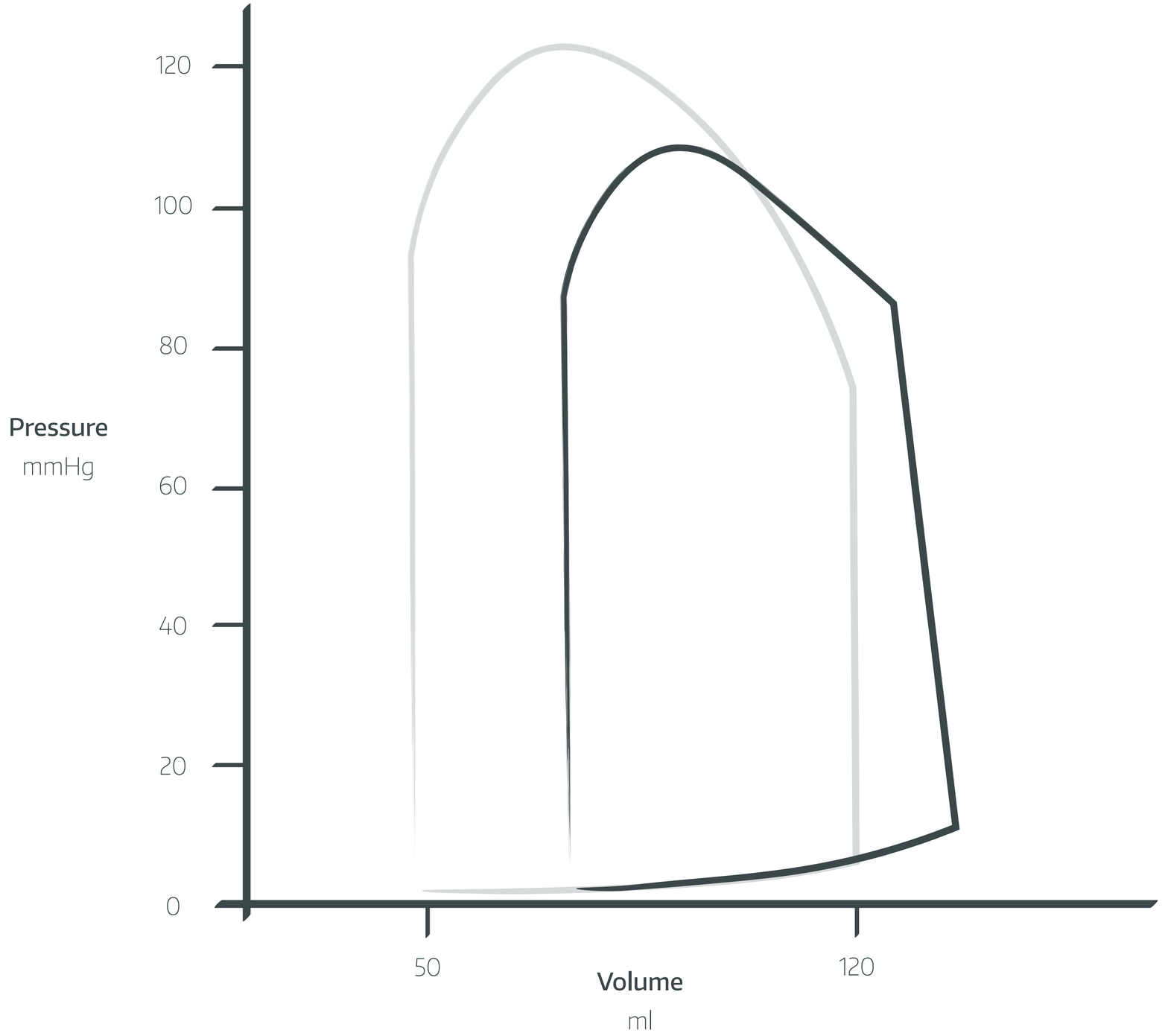
LV Pressure-Volume Loops



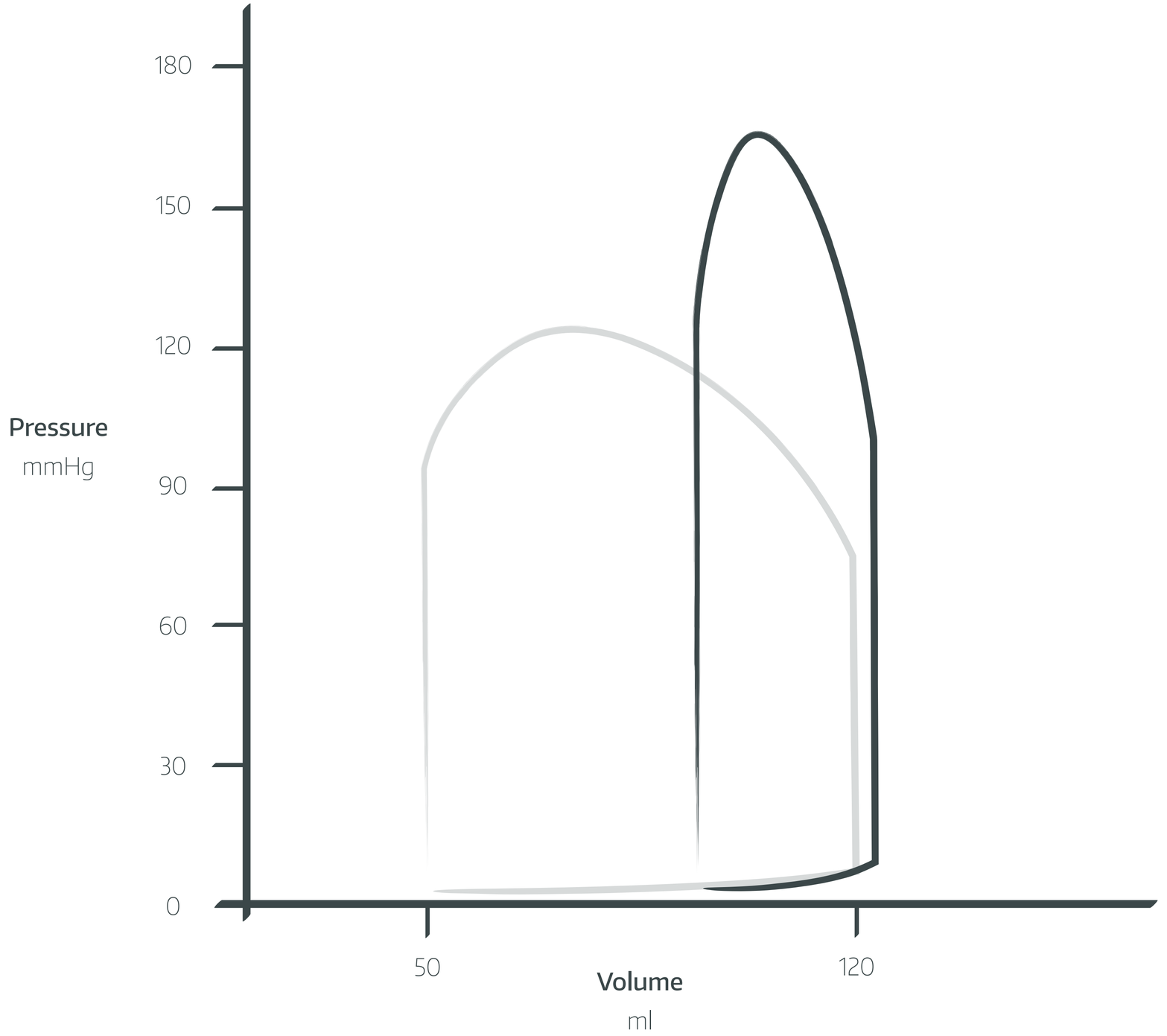
LV Pressure-Volume Loops



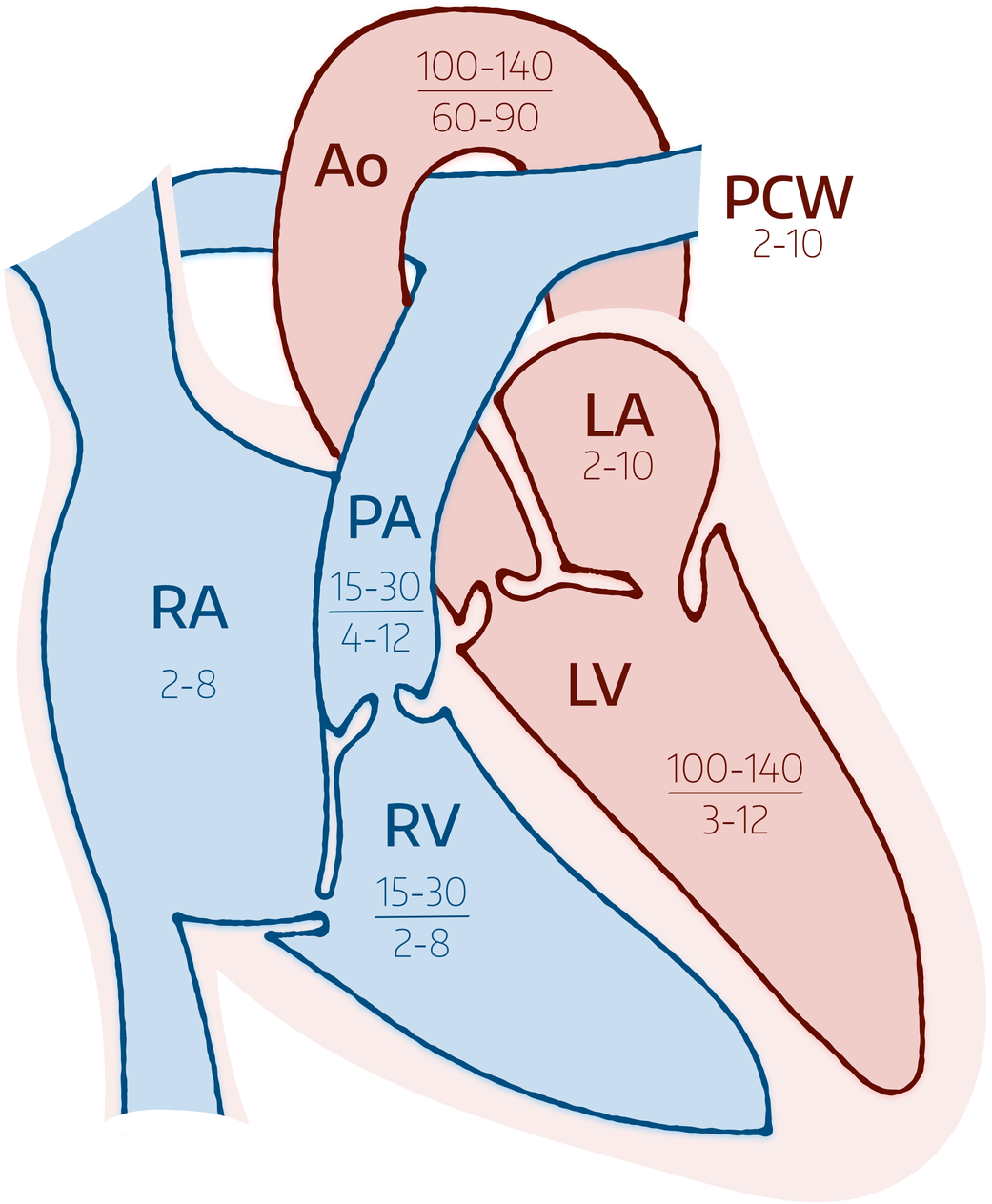
LV Pressure-Volume Loops



LV Pressure-Volume Loops



Intracardiac Pressures



RA
2-8

RV
15-30
2-8

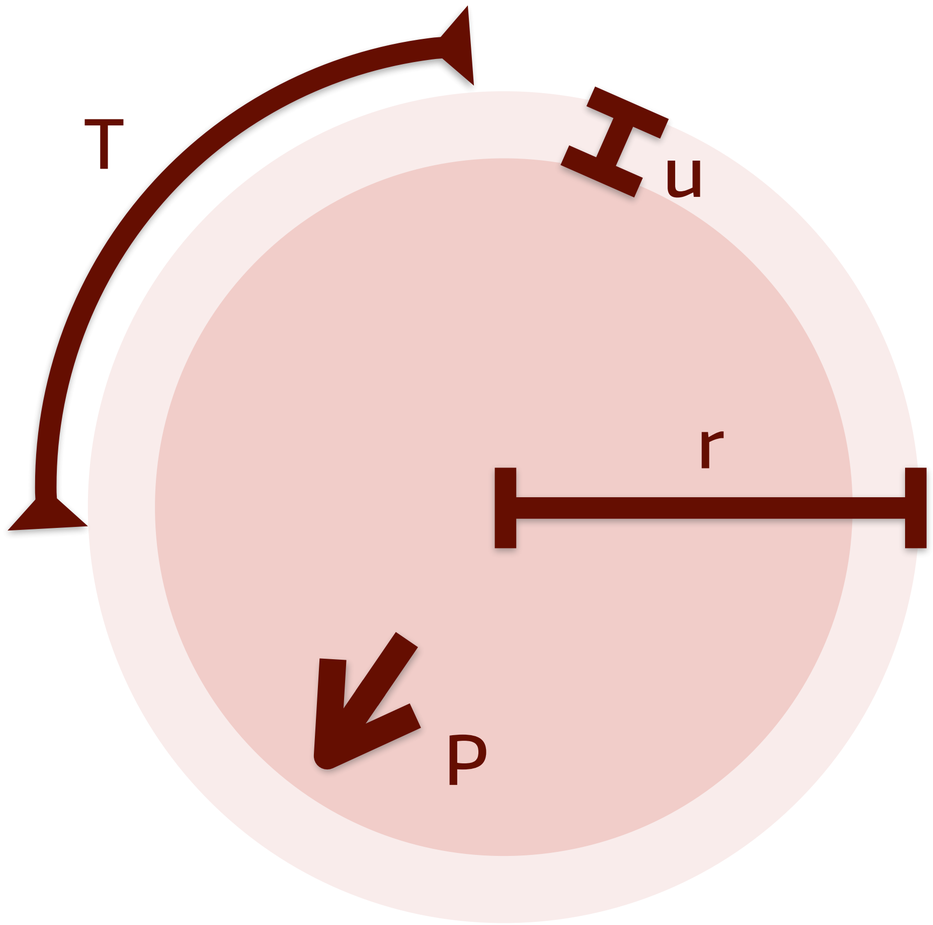
PA
15-30
4-12

LA
2-10

LV
100-140
3-12

Aorta
100-140
60-90

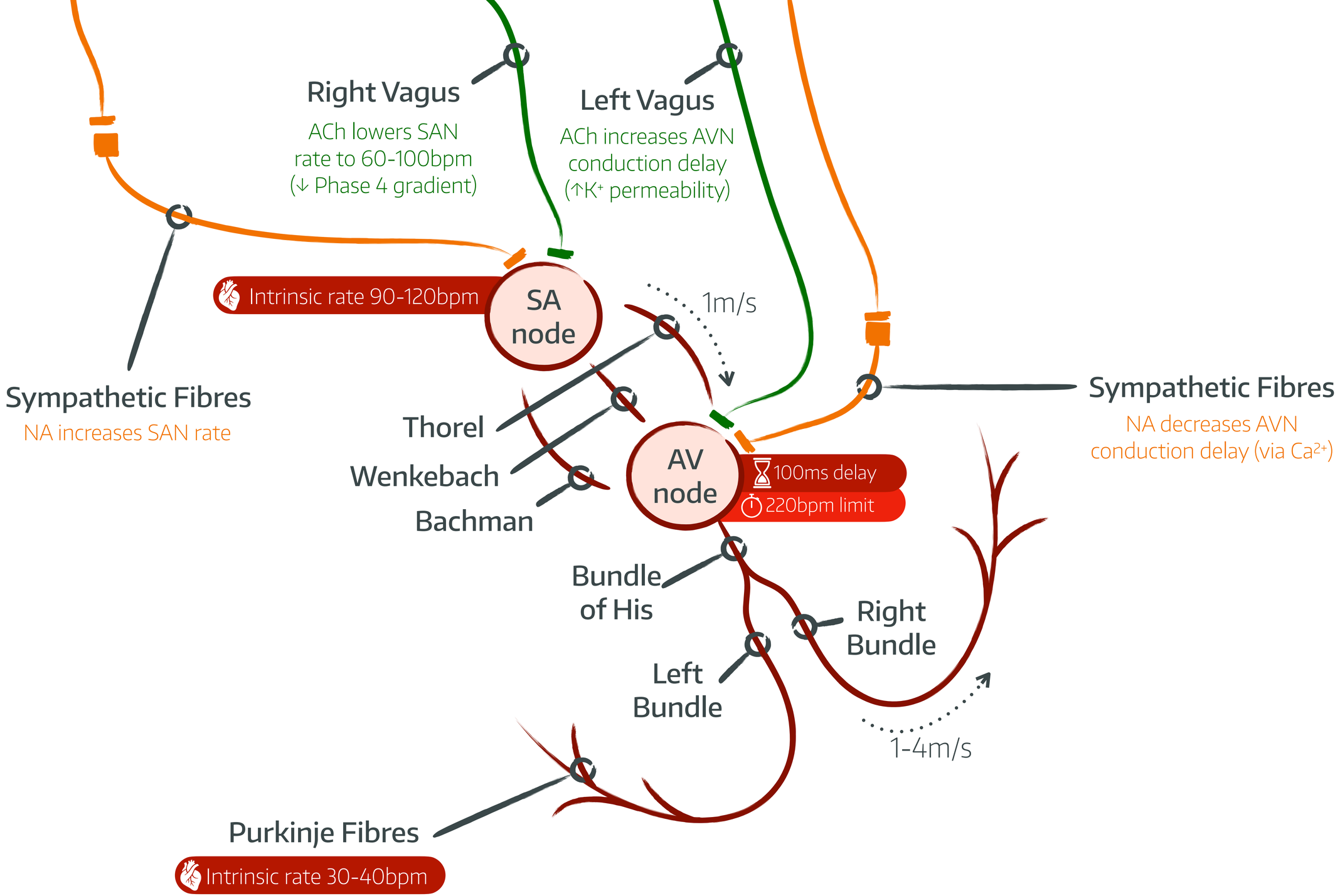
LaPlace's Law



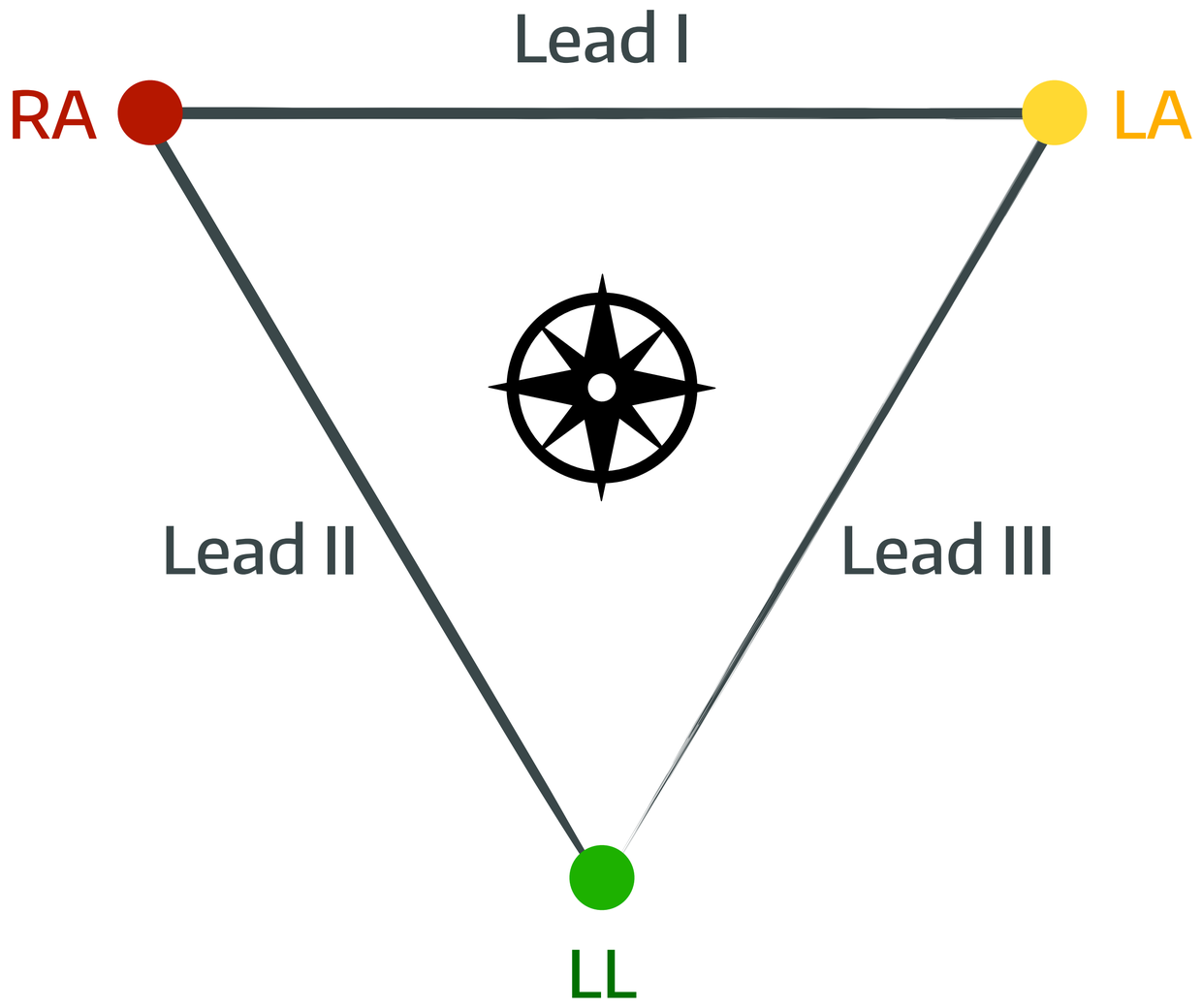
$$T = \frac{rP}{2u}$$

- T: Wall tension
- r: Radius
- P: Transmural Pressure
- u: Wall thickness

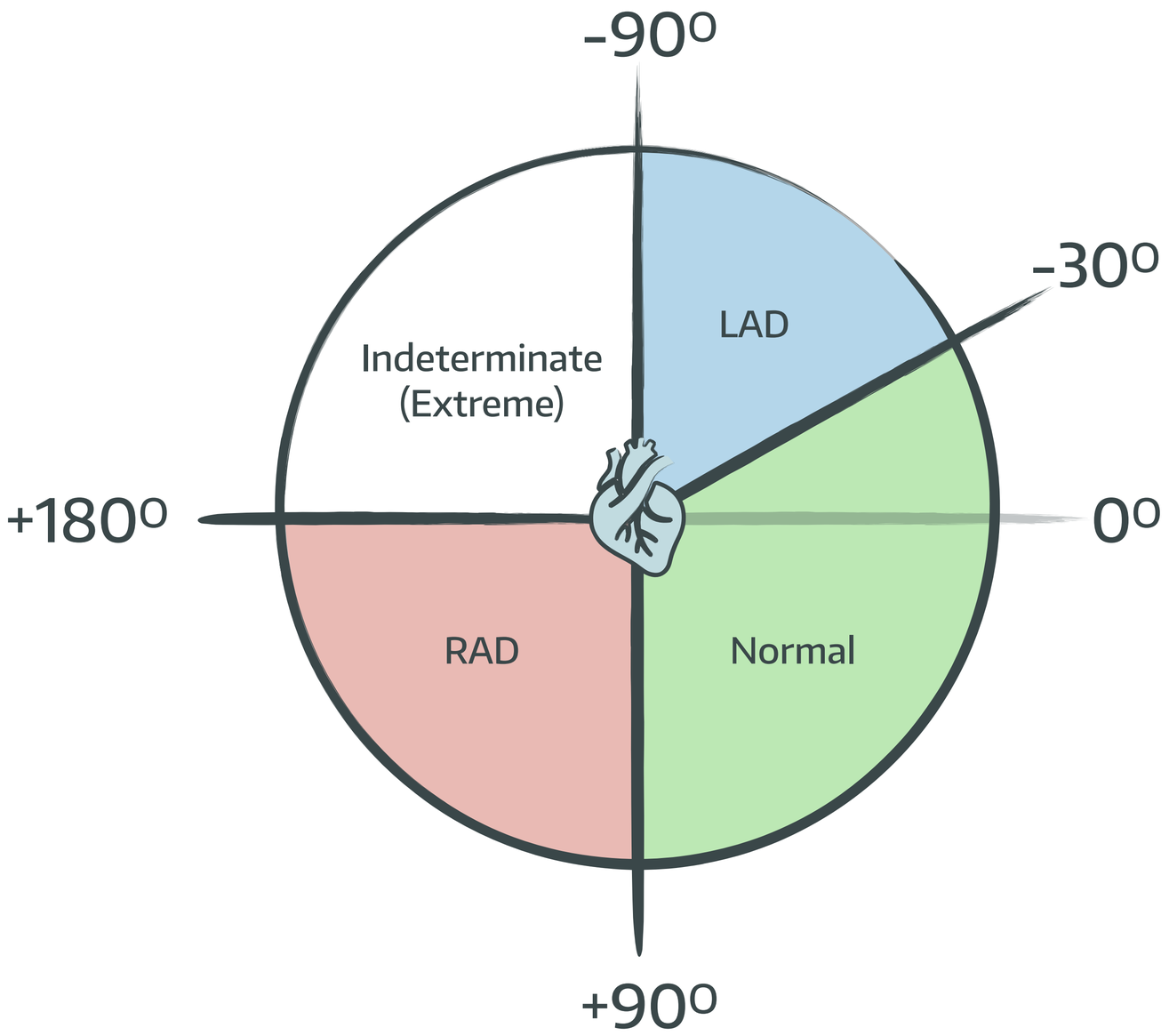
Heart Rate Control



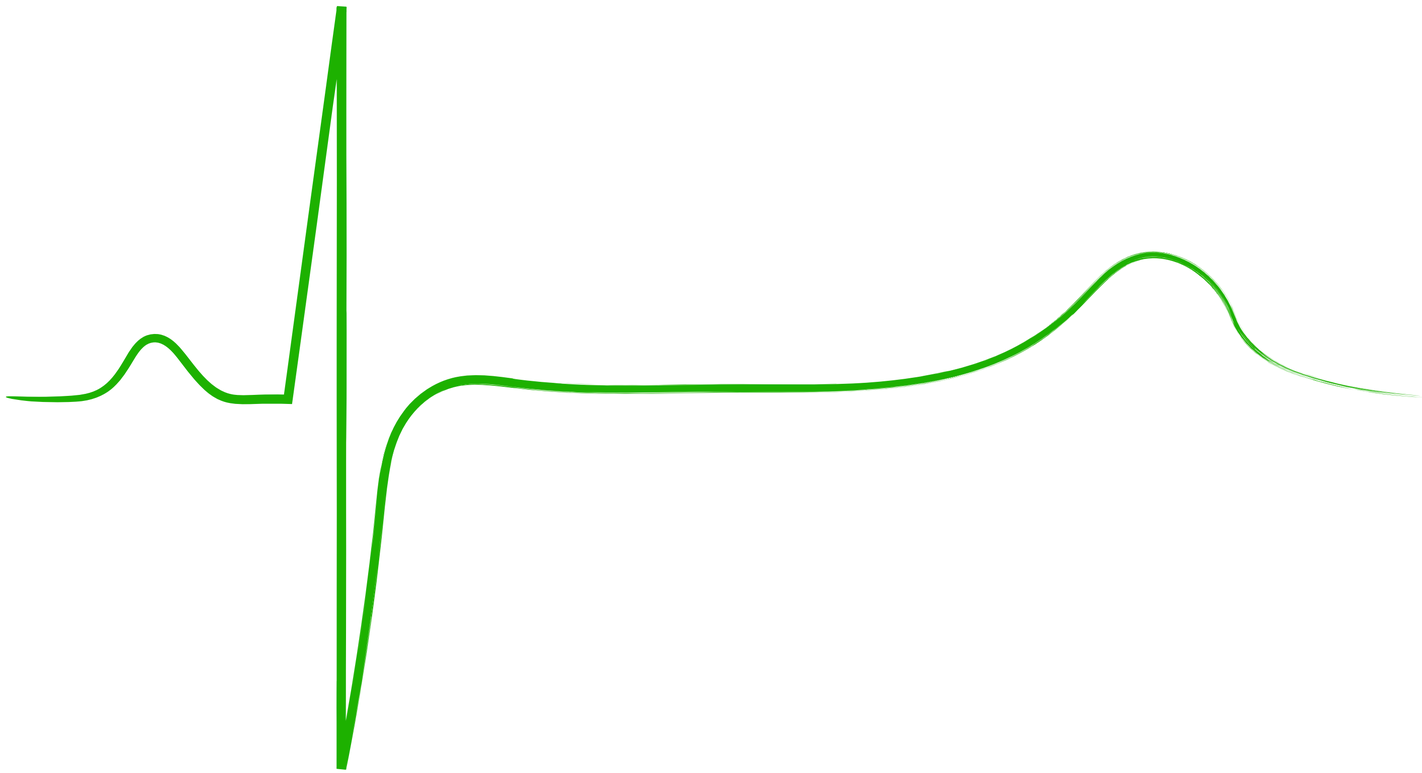
Einthoven's Law



Cardiac Axis

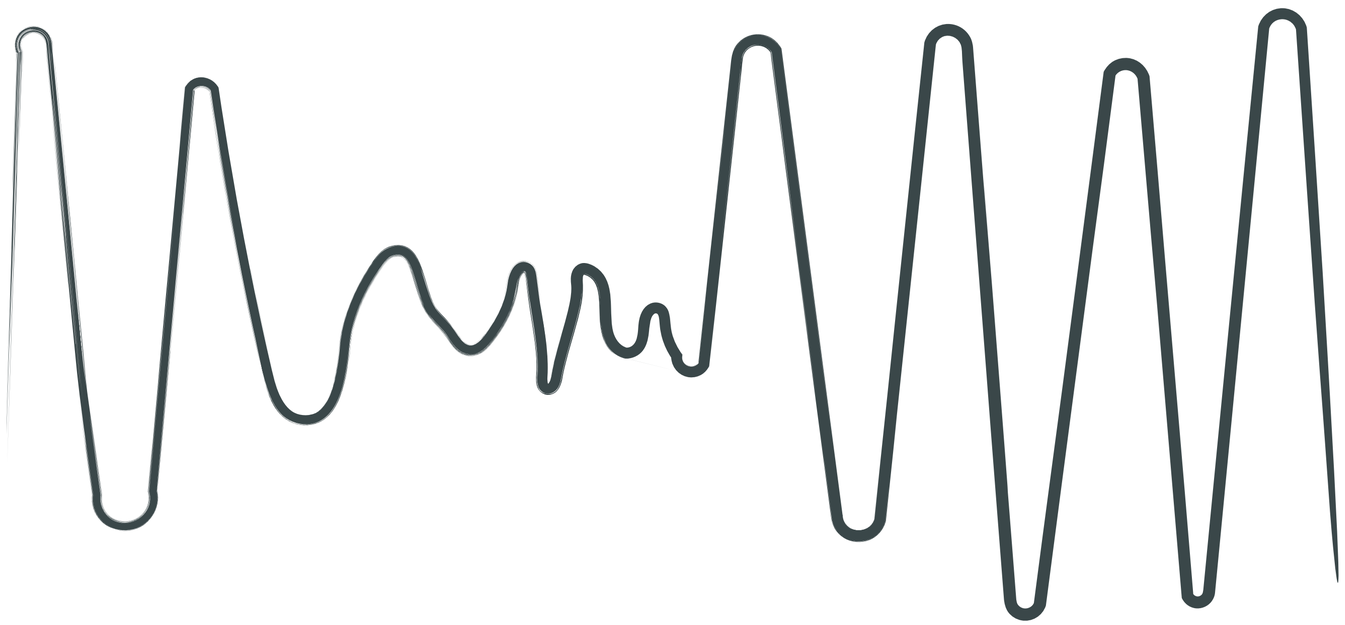


Hypocalcaemia



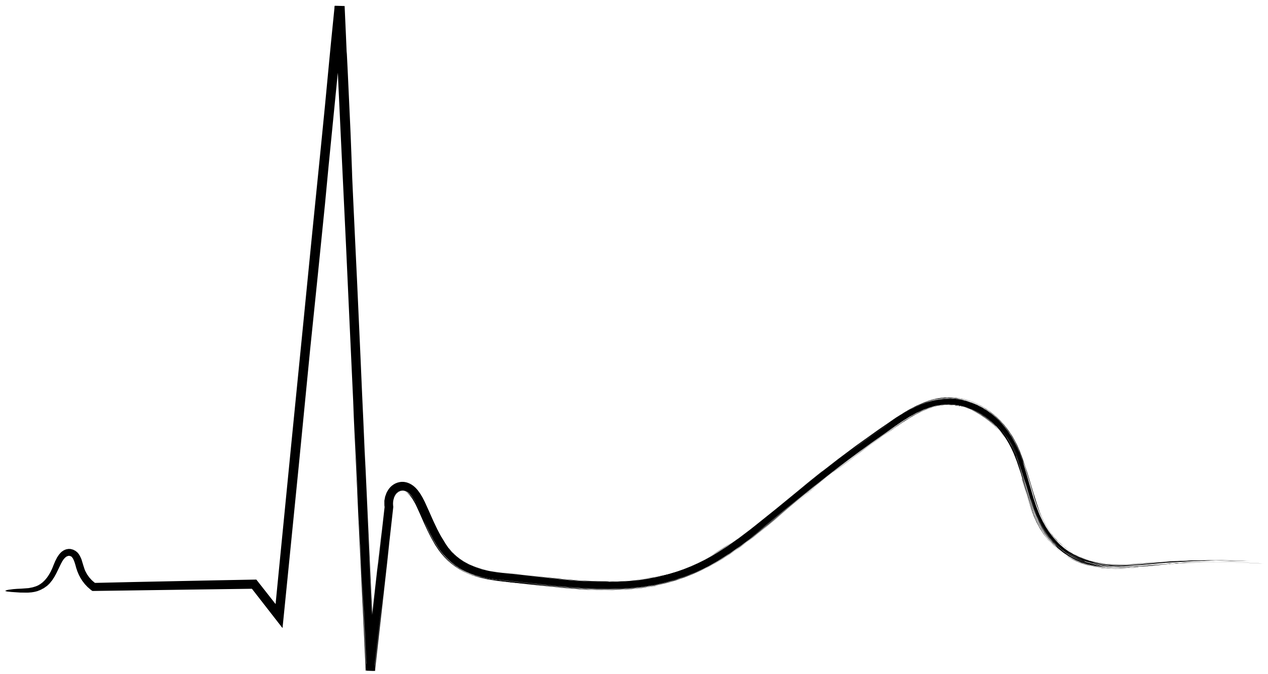
ECG ABNORMALITIES

Torsades de Pointes

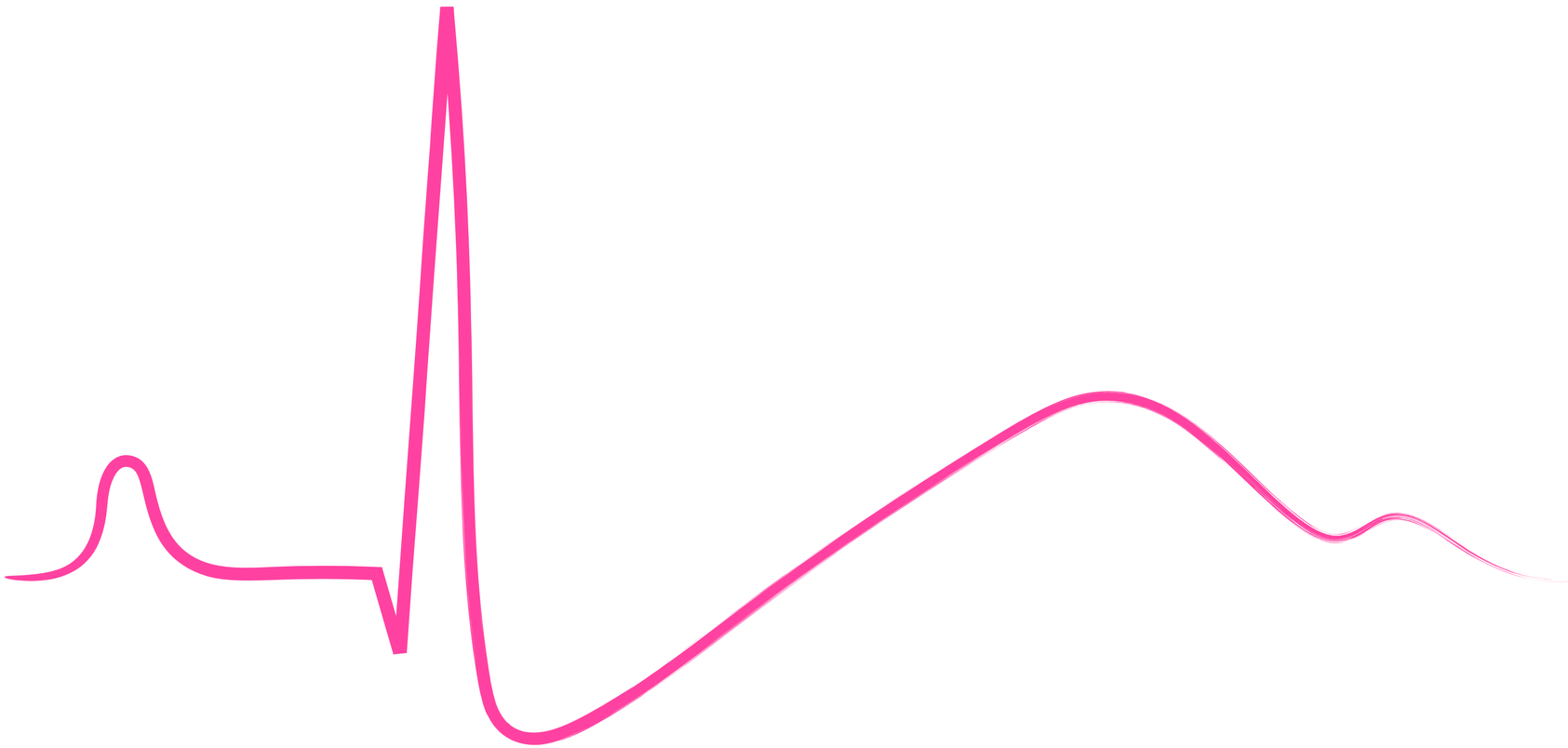


ECG ABNORMALITIES

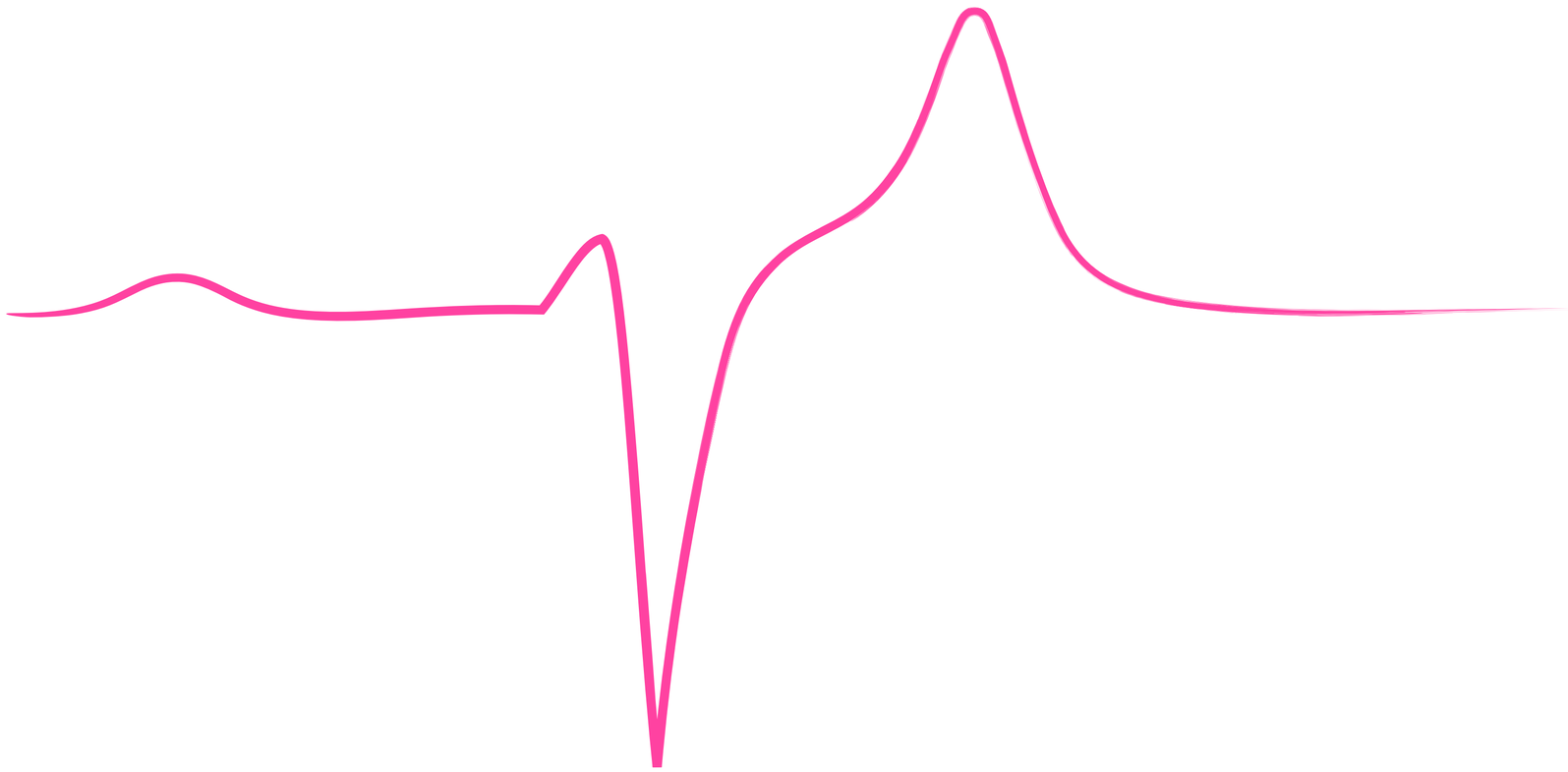
Hypothermia



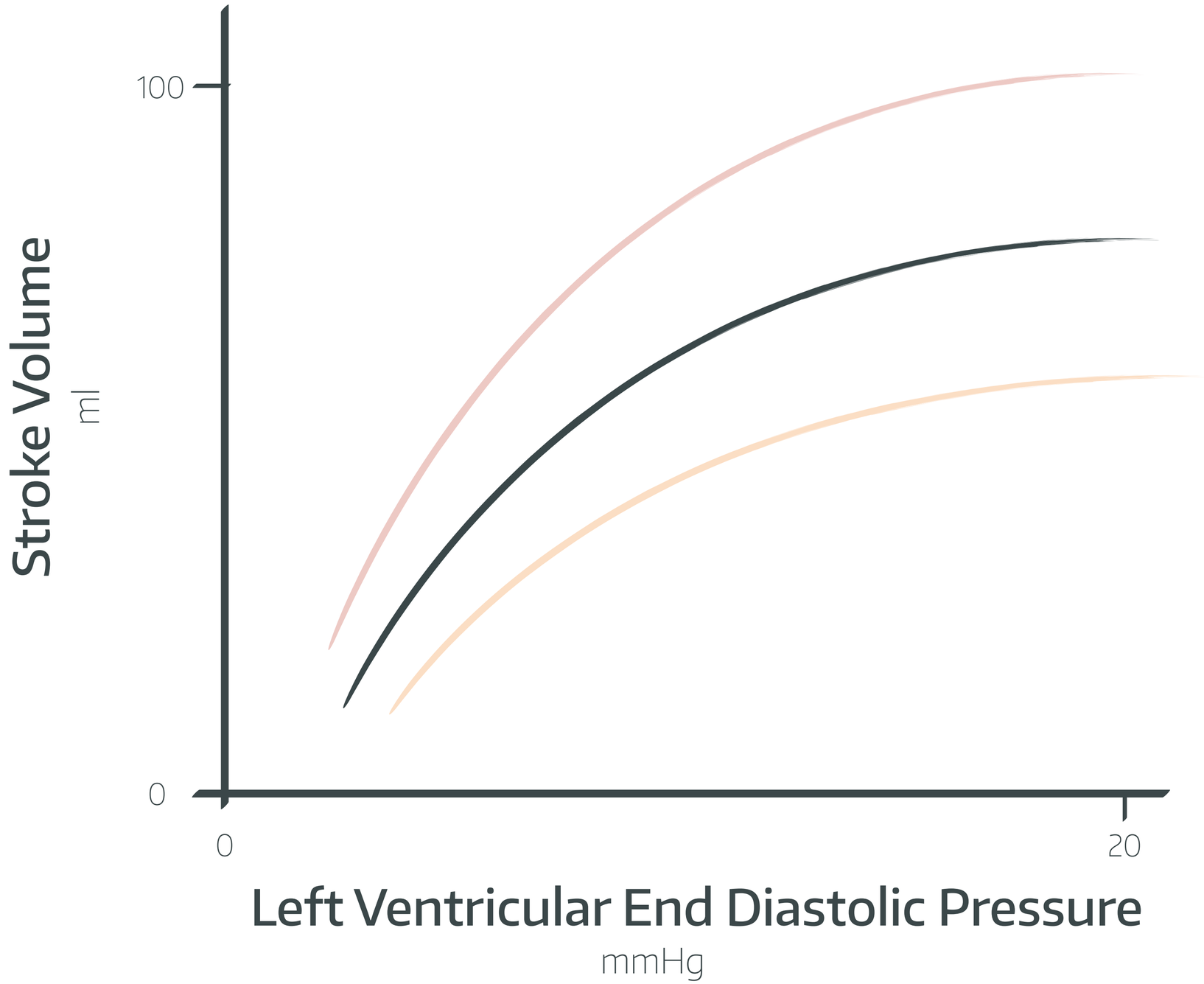
Hypokalaemia



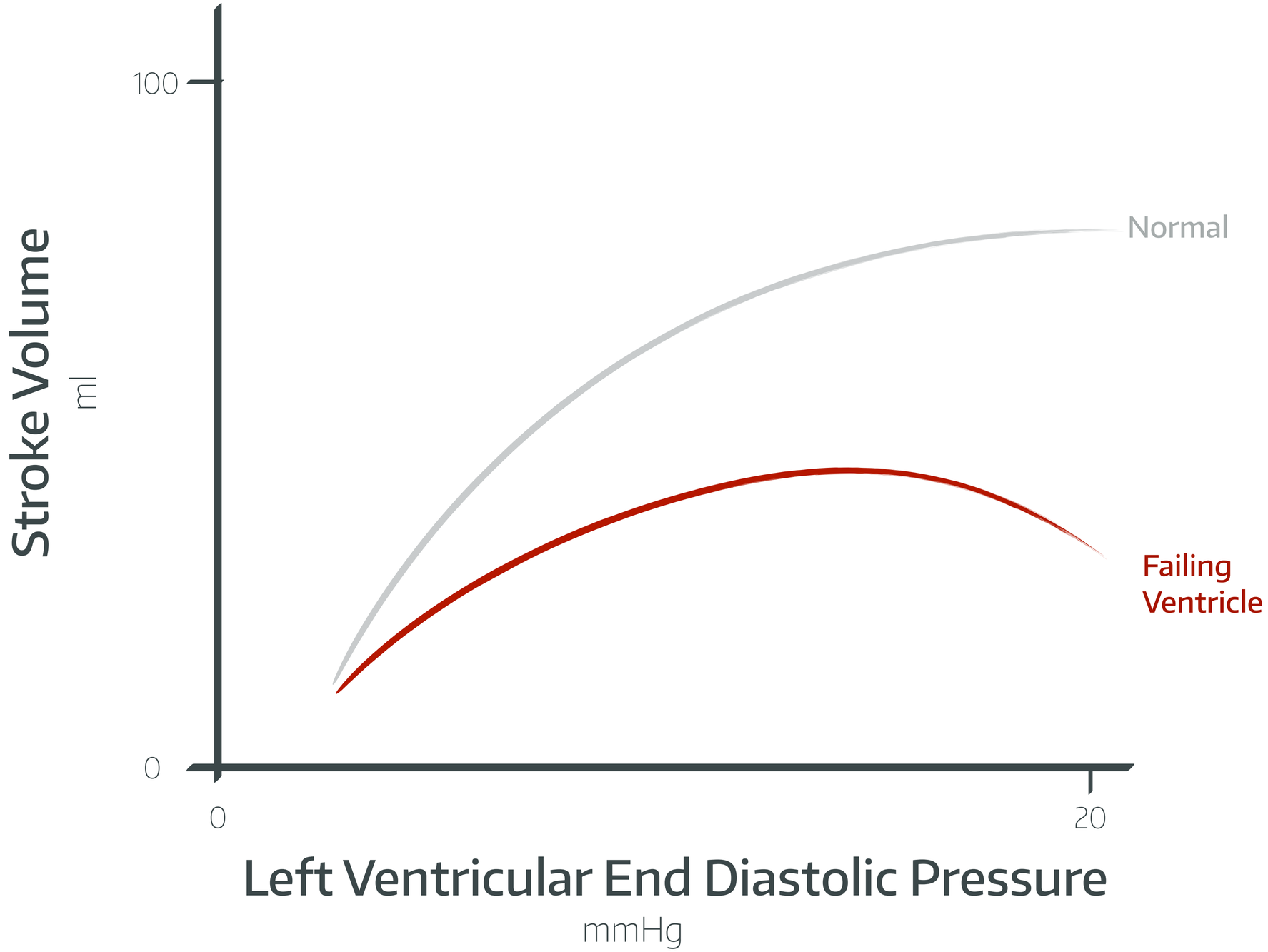
Hyperkalaemia



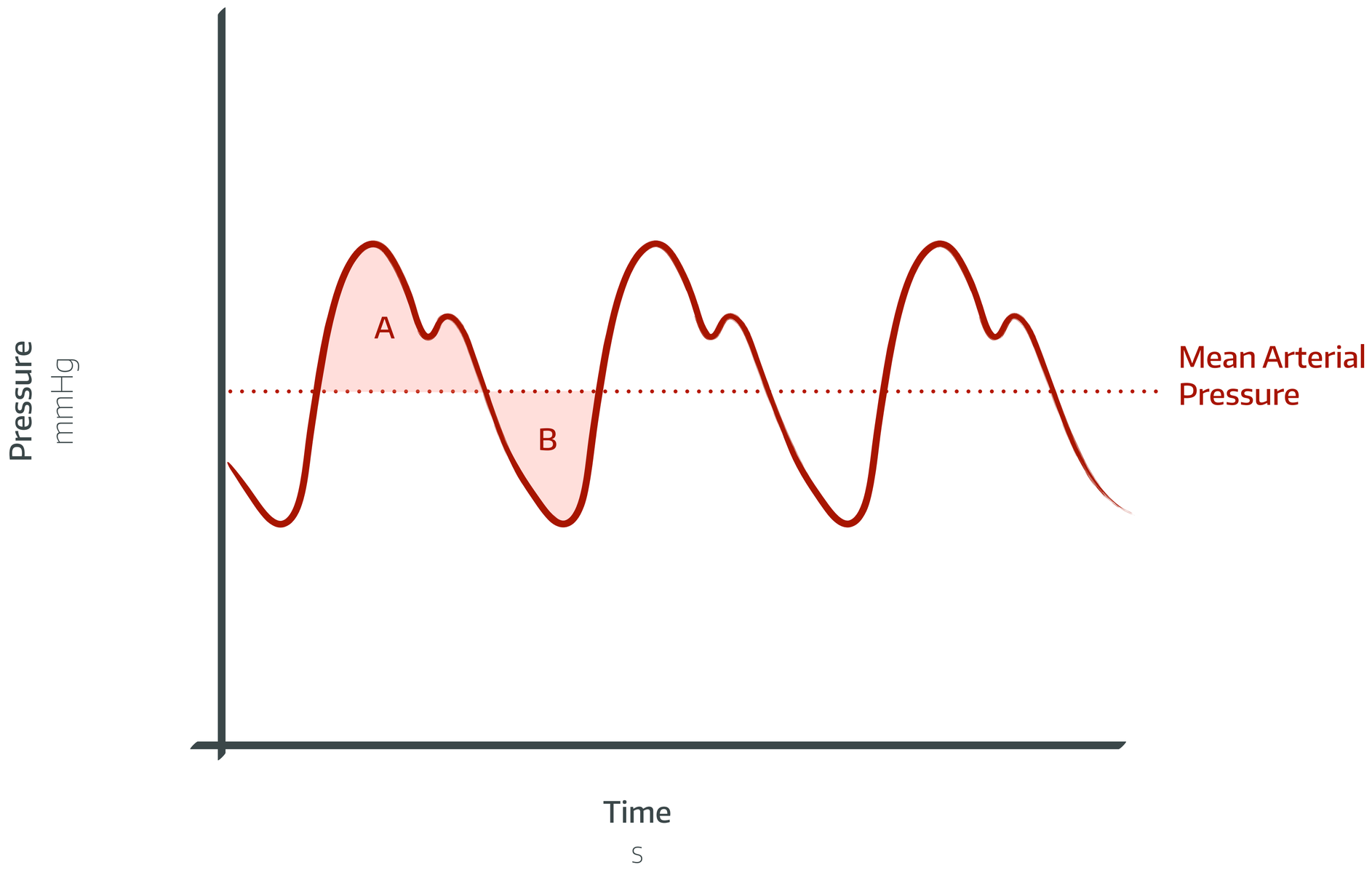
Frank-Starling Curve



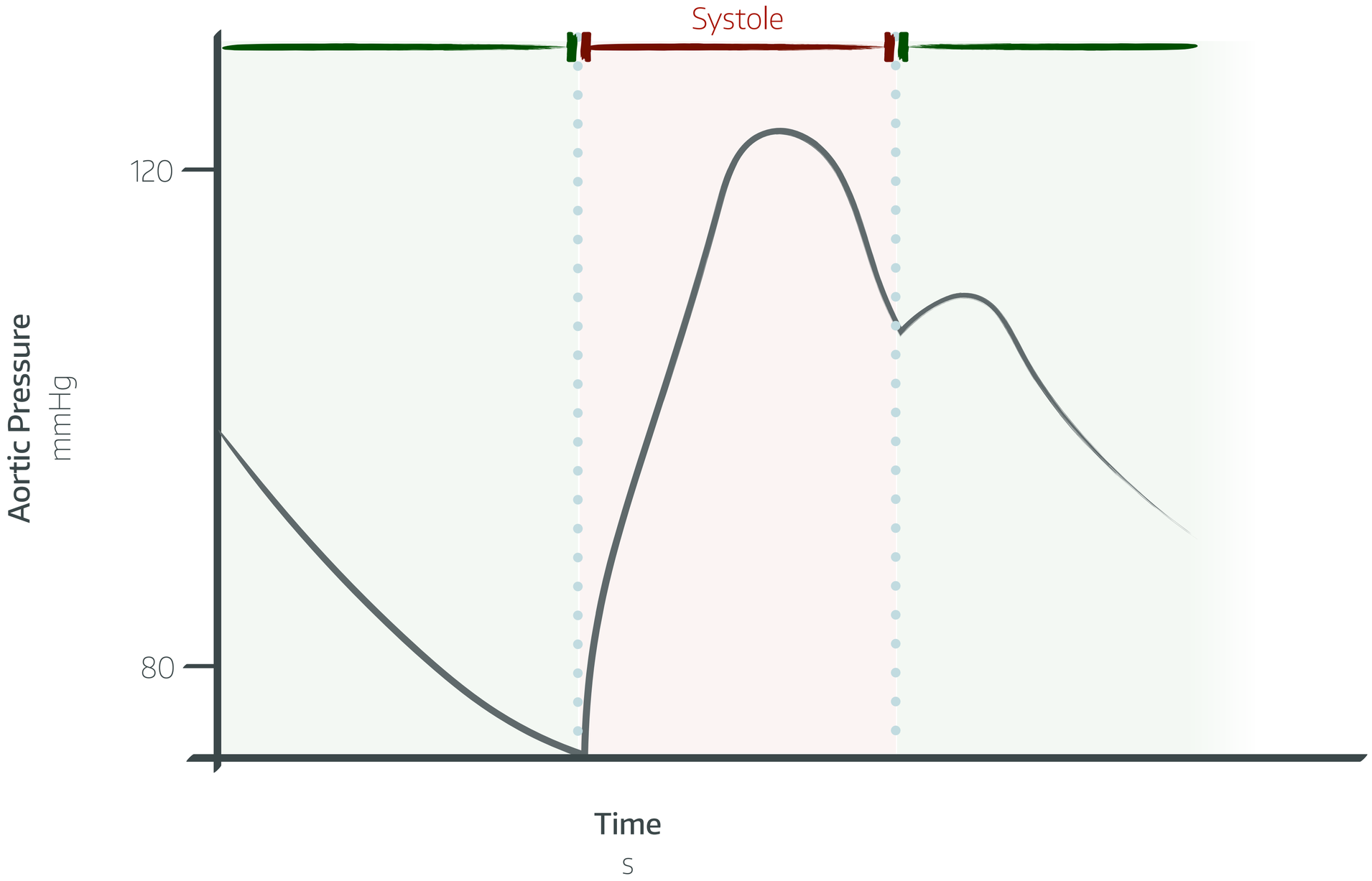
Frank-Starling Curve



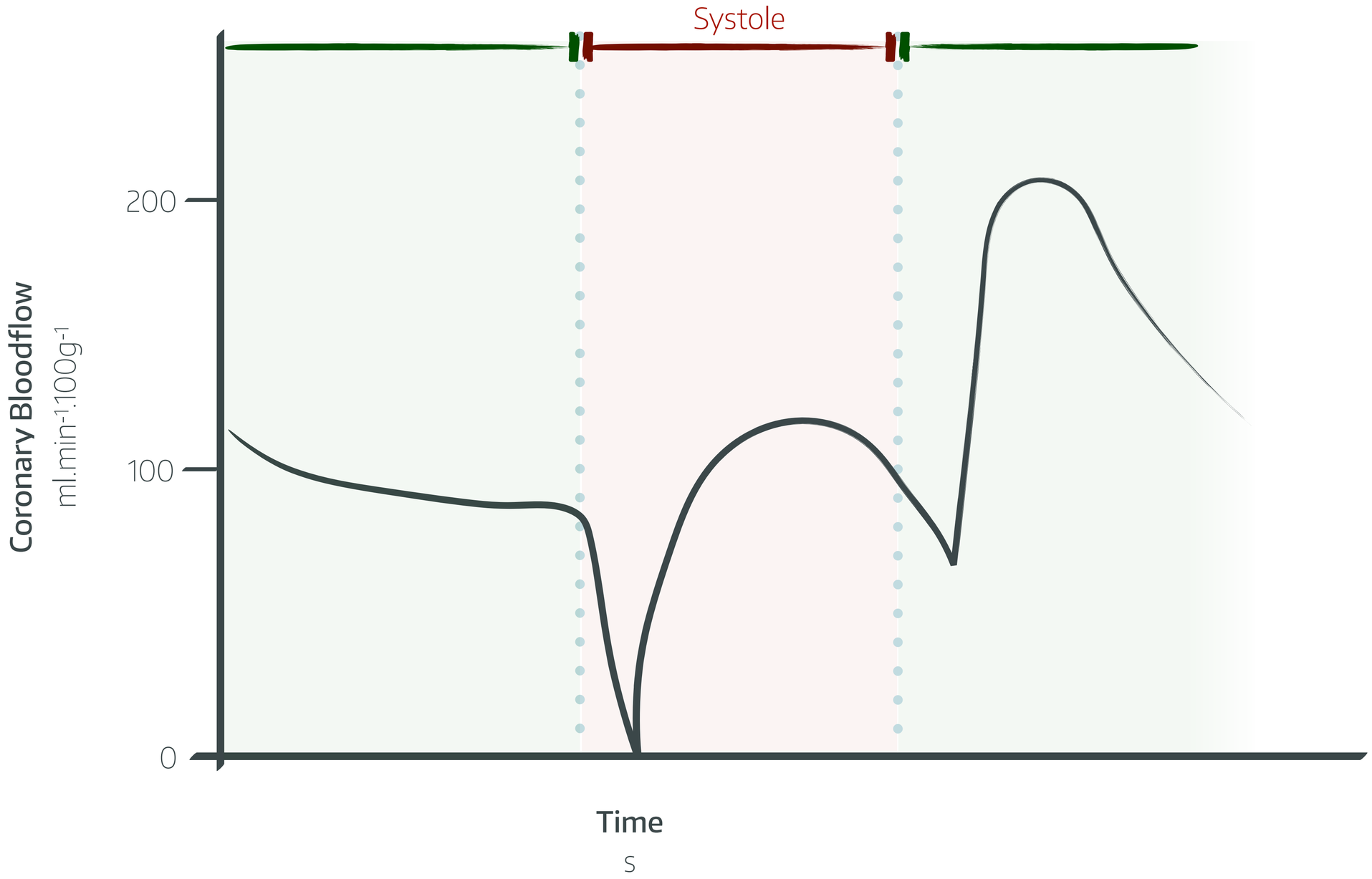
Blood Pressure



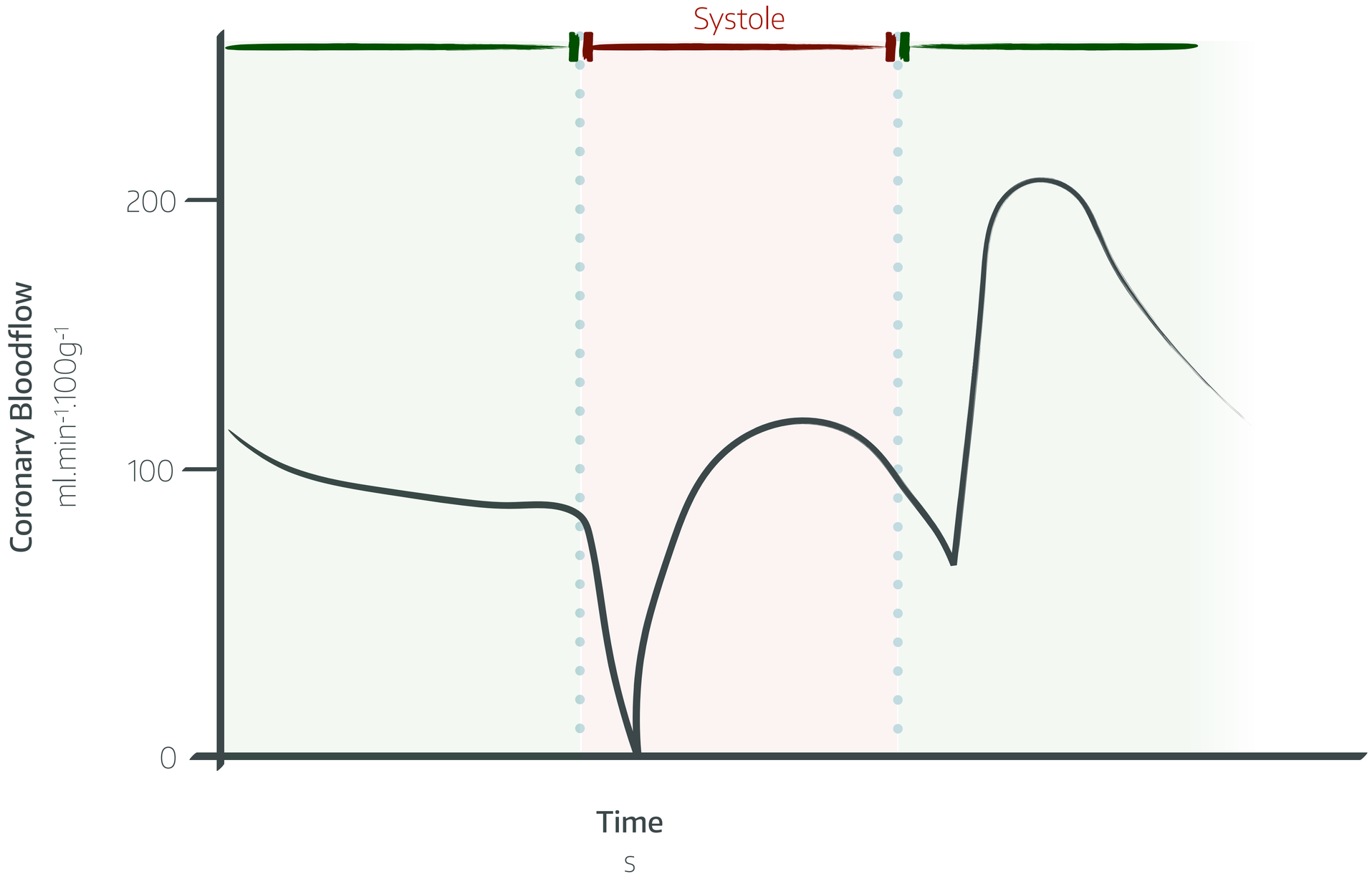
Blood Pressure



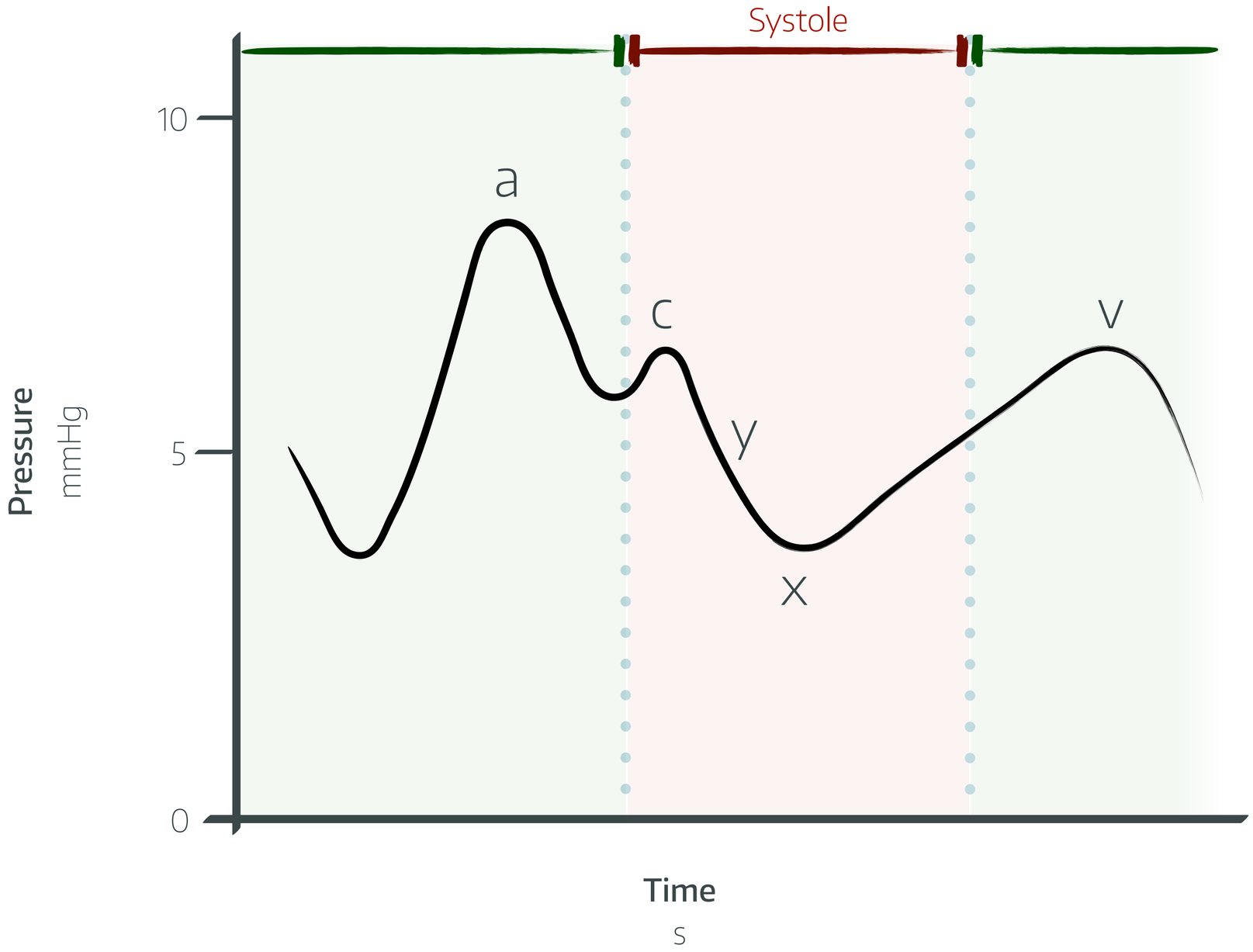
Blood Pressure



Blood Pressure



Central Venous Pressure



Valsalva Manœuvre

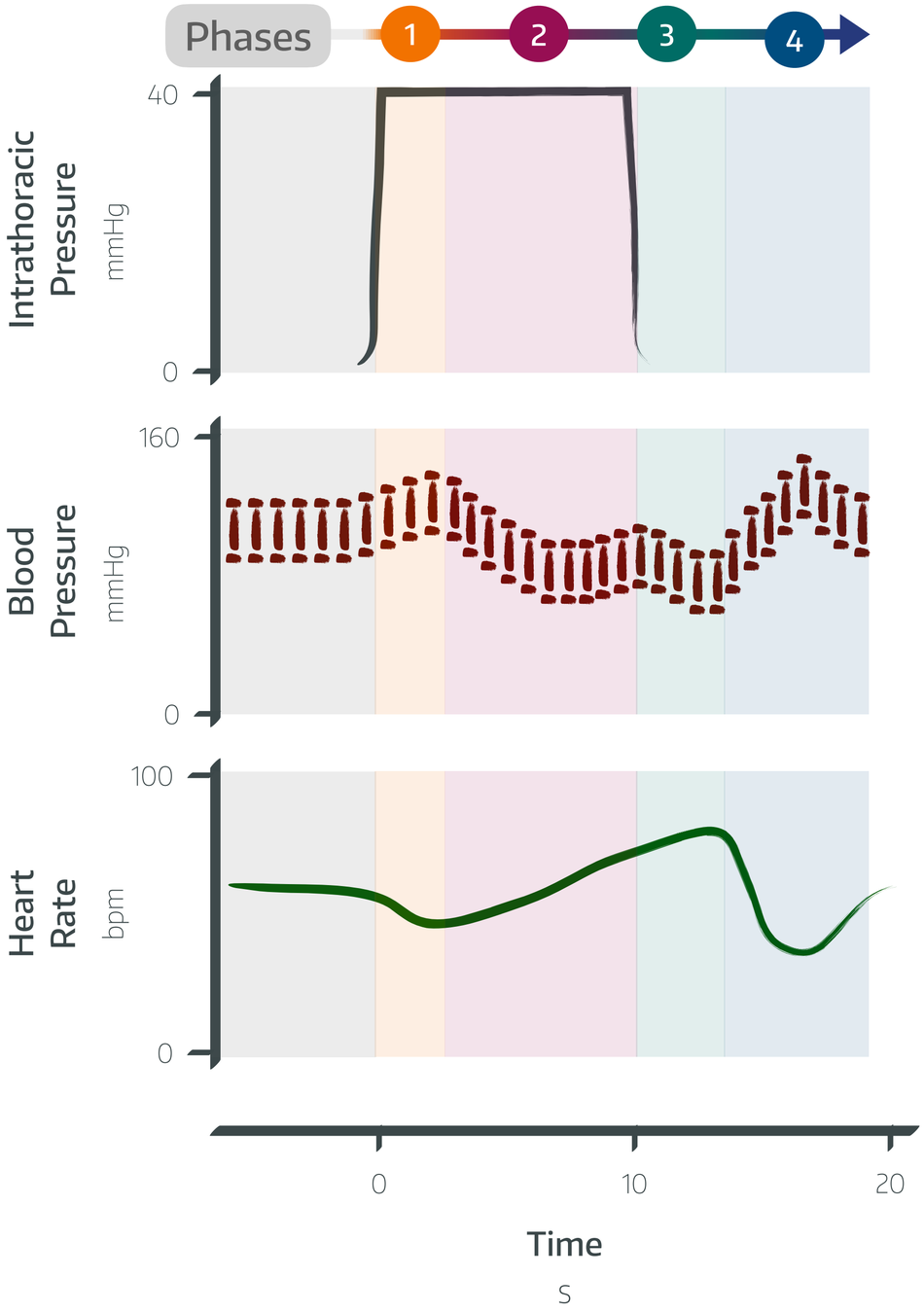
Forced expiration against a **closed glottis**

Phase 1
Onset of Pressure
Compression of Pulmonary Capacitance Vessels → Increased Venous Return → Raised BP → Reflex Bradycardia

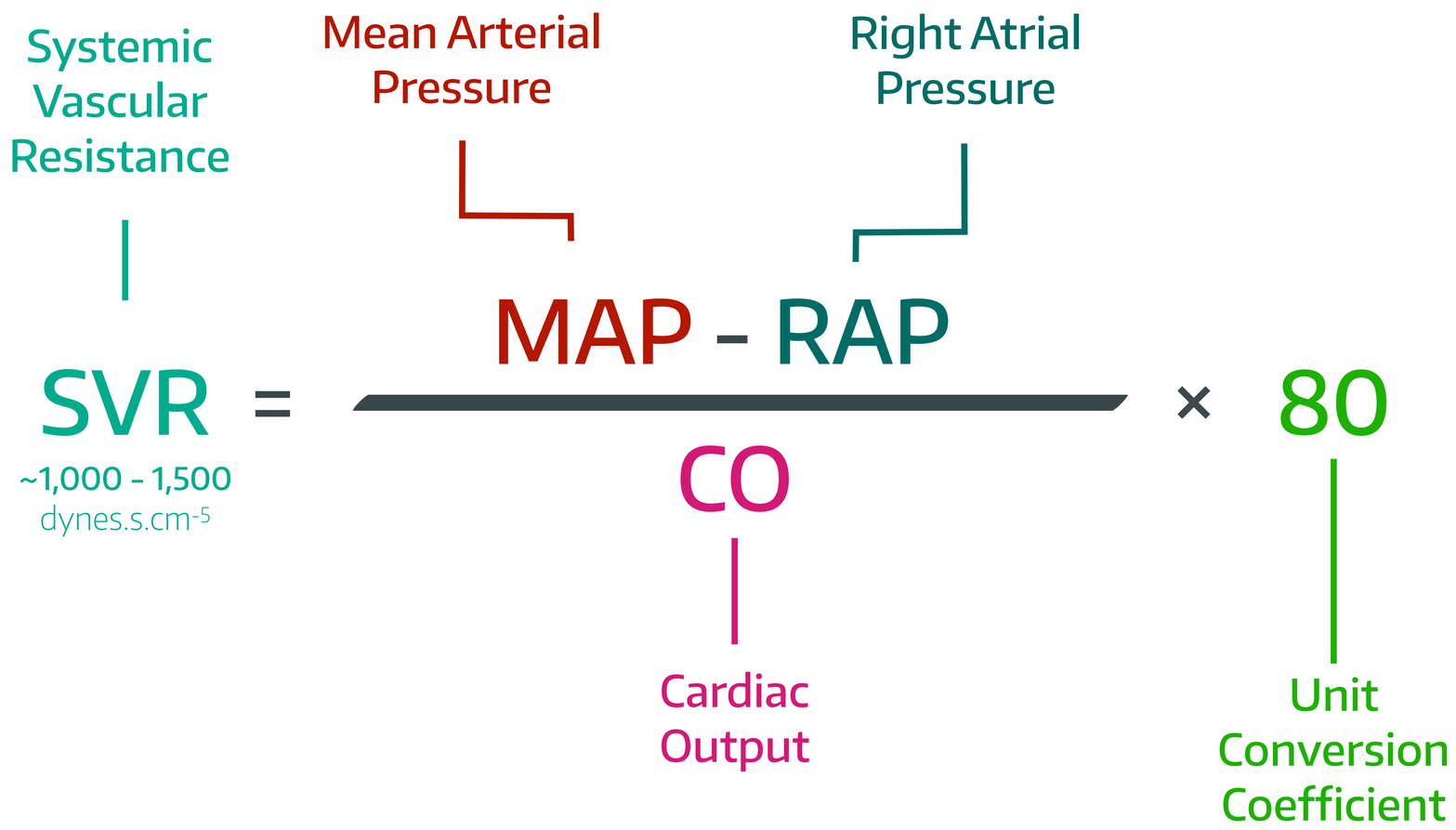
Phase 2
Maintenance of Pressure
Reduced Venous Return → Reduced BP → Reflex Tachycardia → Eventually restores BP

Phase 3
Release of Pressure
Large, empty Venous Reservoir → Low Venous Return → Reduced BP → Reflex Tachycardia

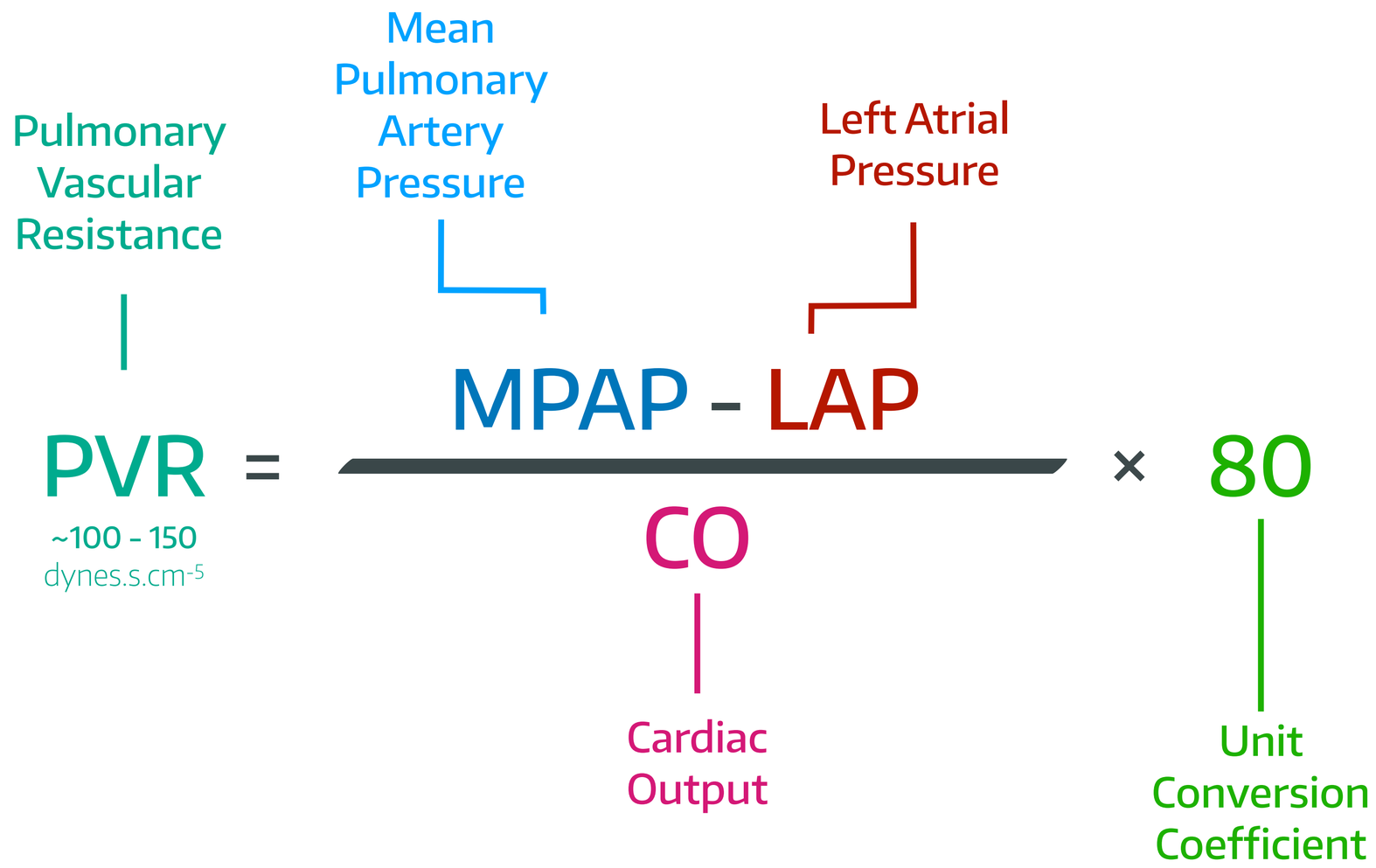
Phase 4
Until normal pressures reached
Venous Return Restored → Increased BP → Reflex Bradycardia.
All parameters then normalise.



Systemic Vascular Resistance



Pulmonary Vascular Resistance



VENOUS RETURN

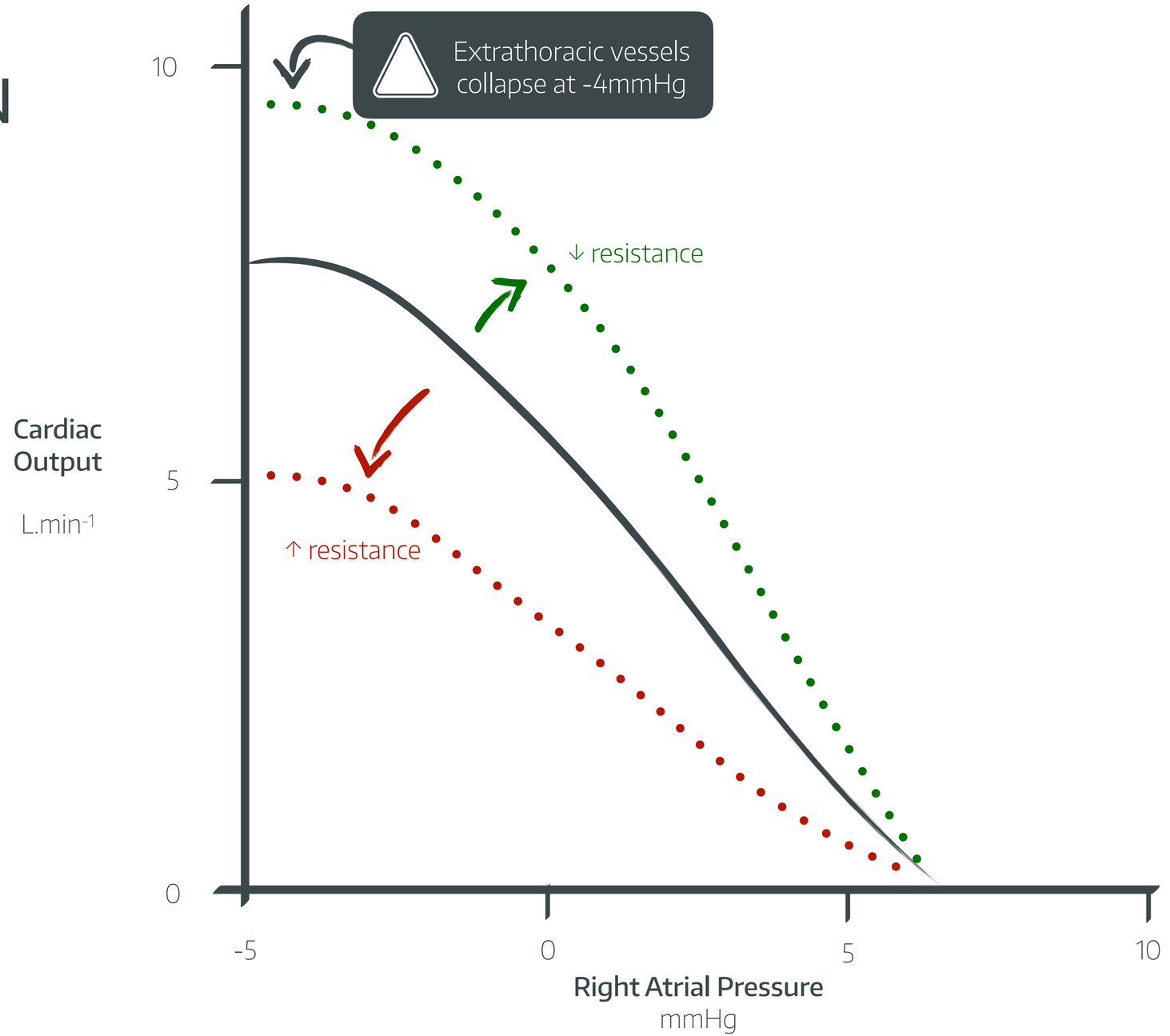
$$= \frac{MSFP - RAP}{R_{ven}} \times 80$$

Mean Systolic Filling Pressure

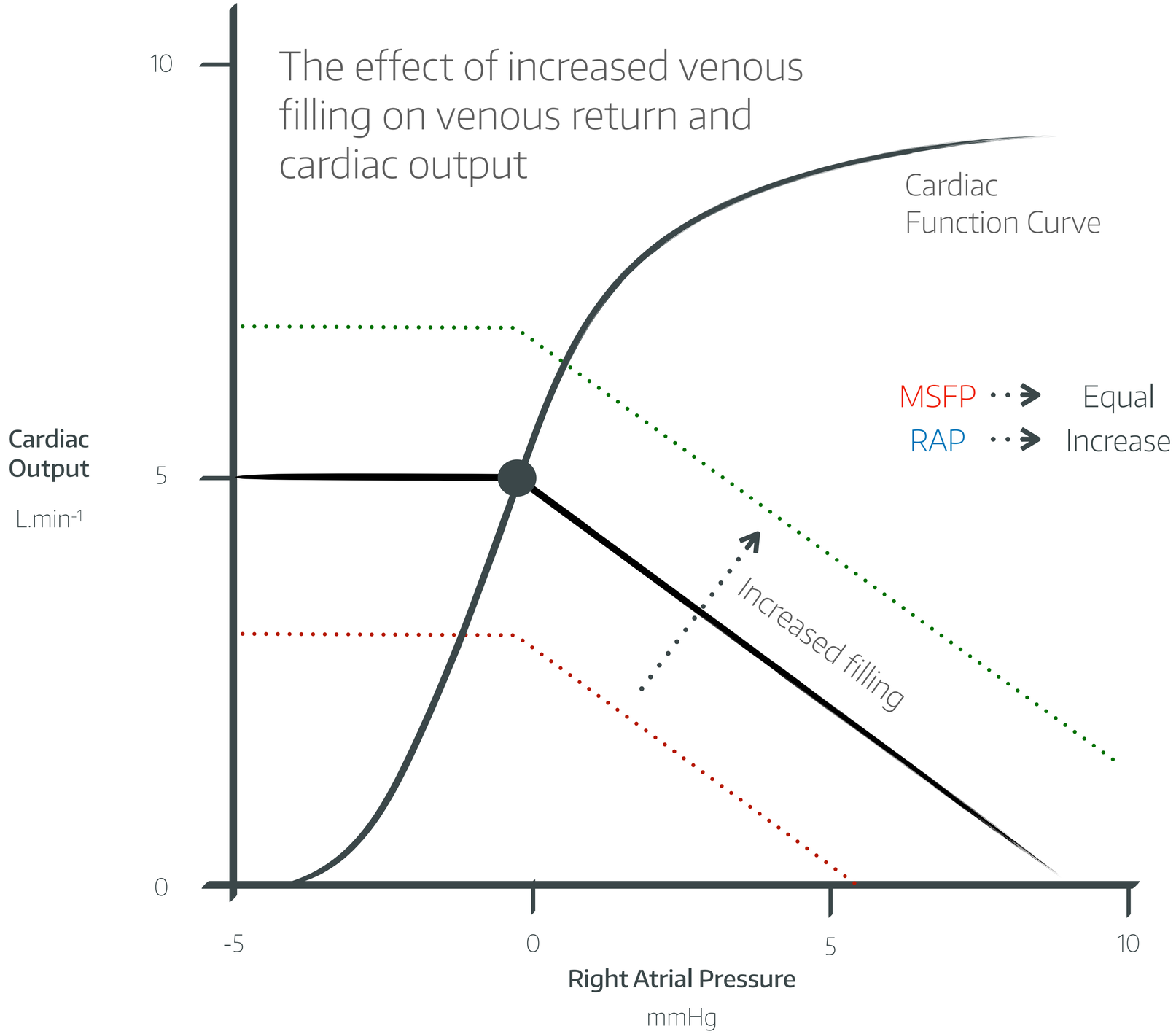
= weighted average of systemic circulation pressures

Right Atrial Pressure

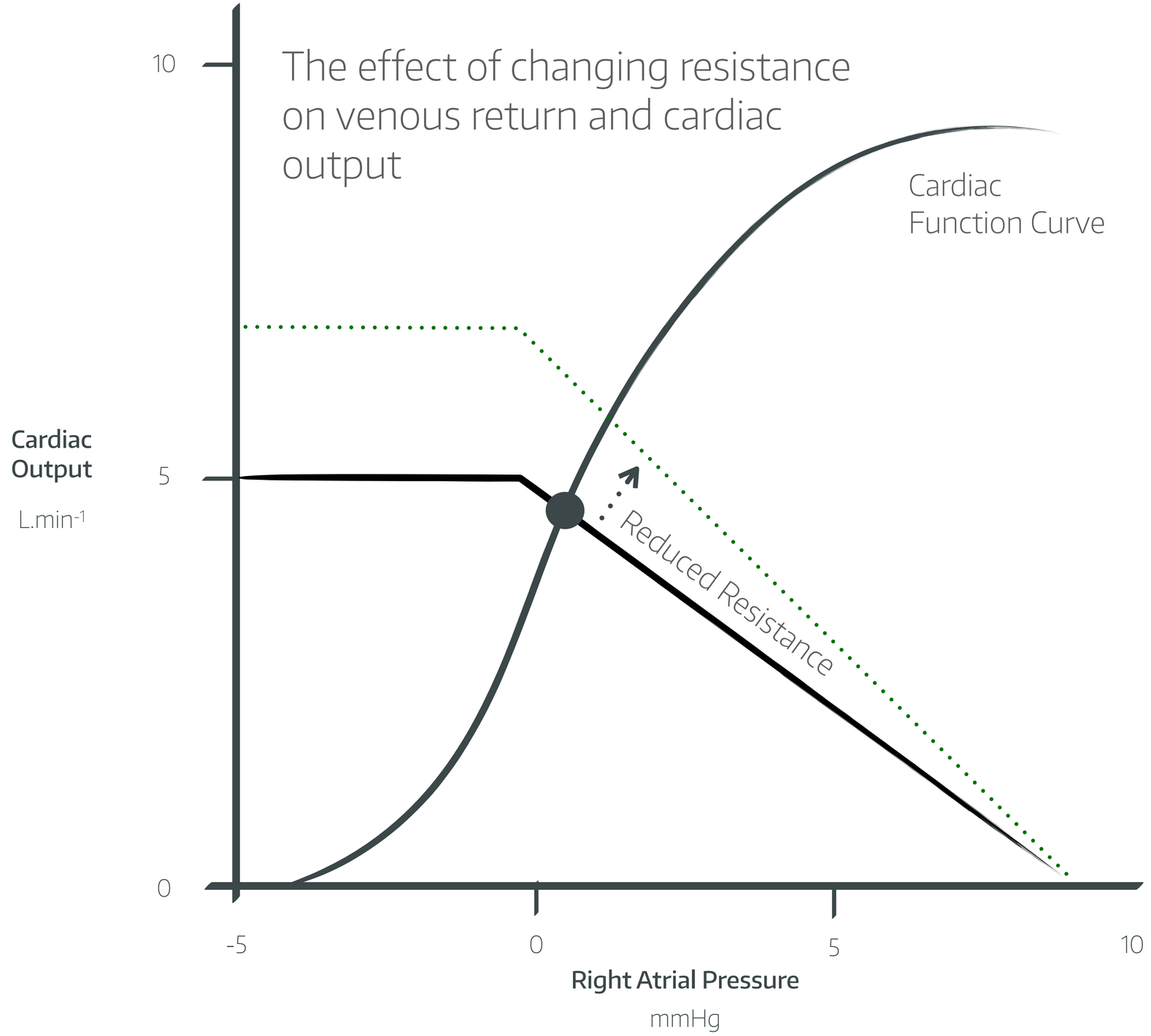
Venous Resistance



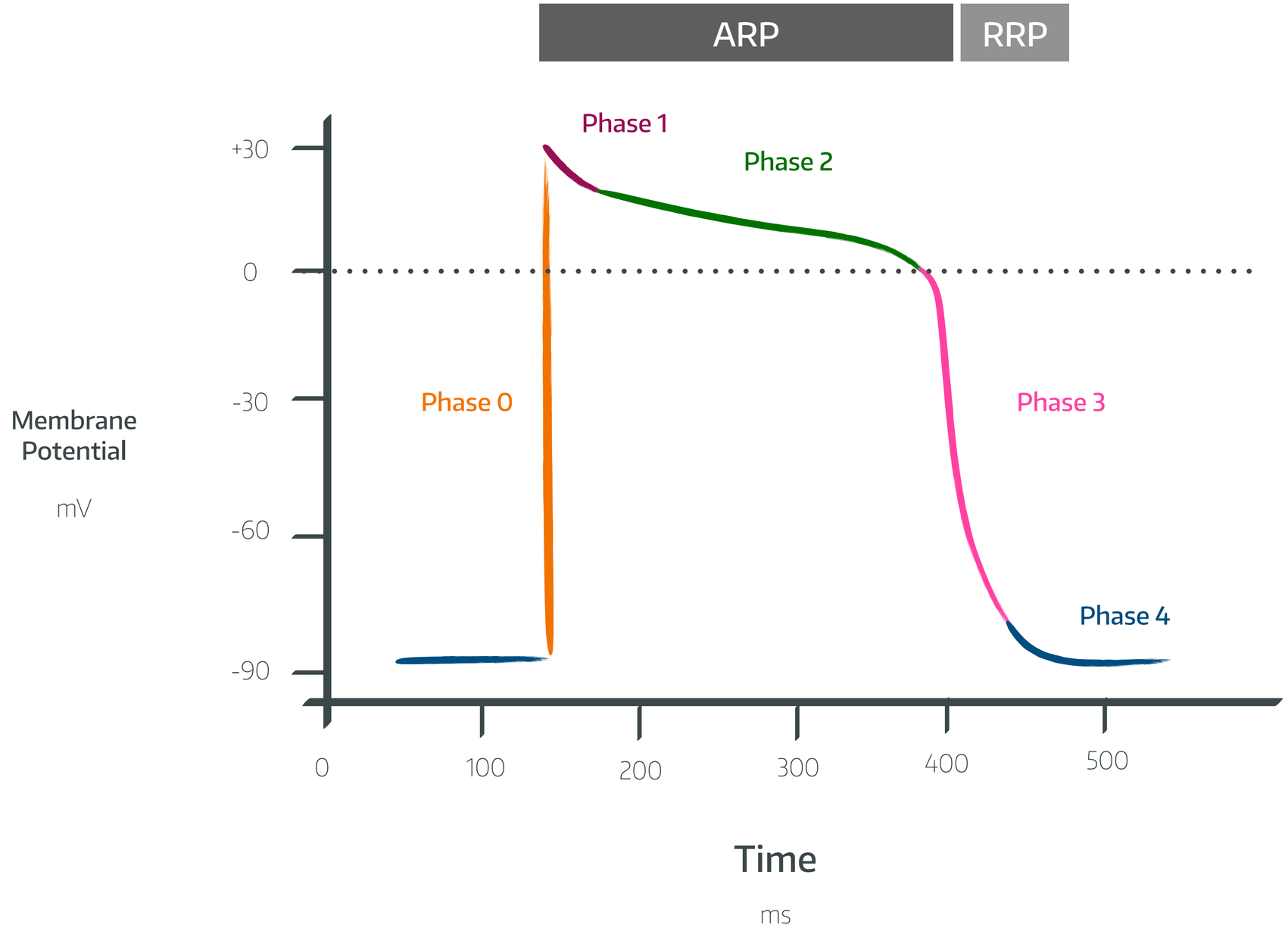
Cardiac Physiology



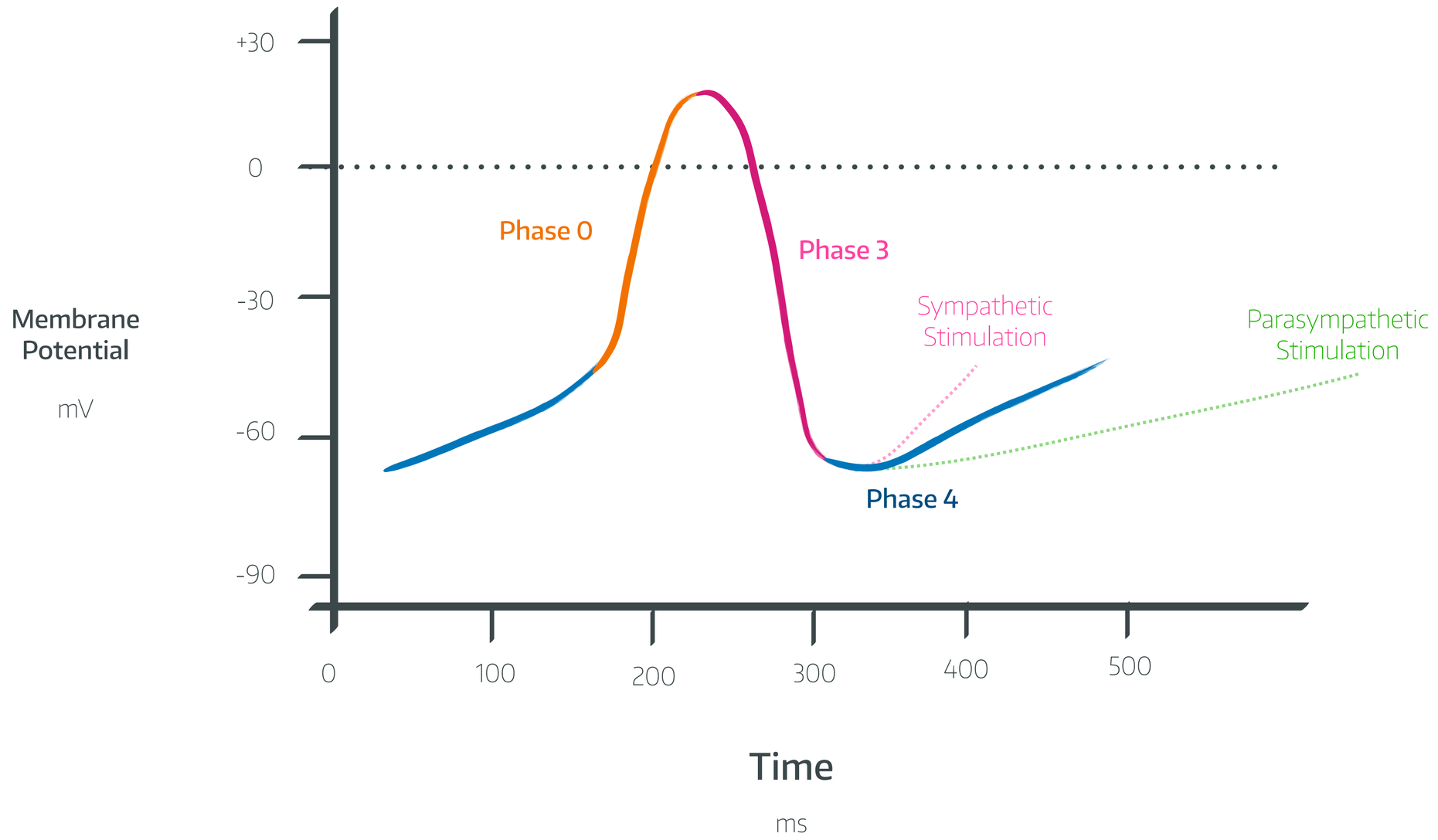
Cardiac Physiology



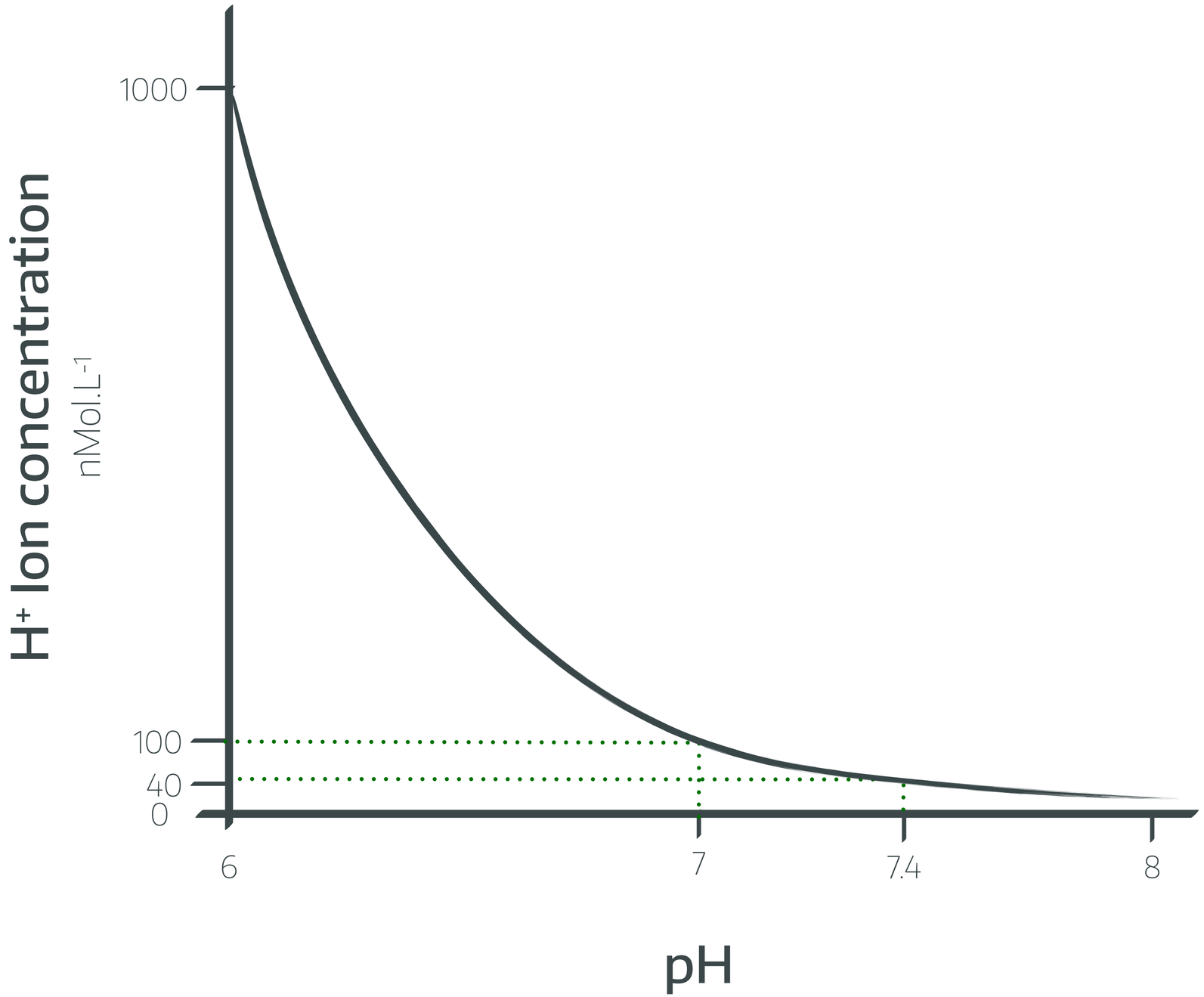
Cardiac Action Potential



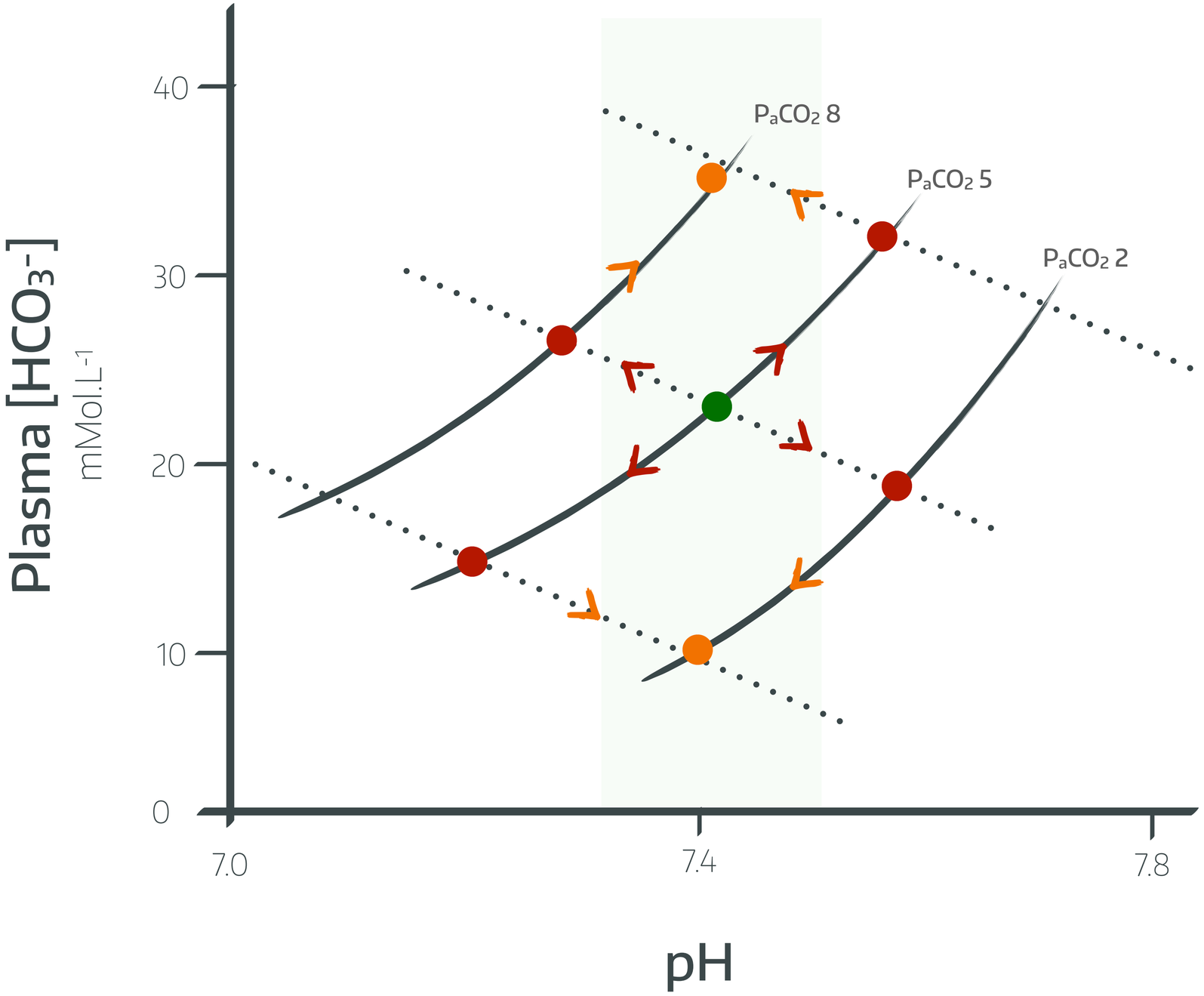
Cardiac Action Potential



BIOCHEMISTRY



BIOCHEMISTRY



BIOCHEMISTRY

‘Raised Anion Gap’ Metabolic Acidosis

C Carbon Monoxide / Cyanide
Congenital Heart Failure

A Aminoglycosides

T Toluene Glue
Theophylline

M Methanol

U Uraemia

D Diabetic Ketoacidosis

P Paraldehyde
Paracetamol

I Iron / Isoniazid
Inborn Errors of Metabolism

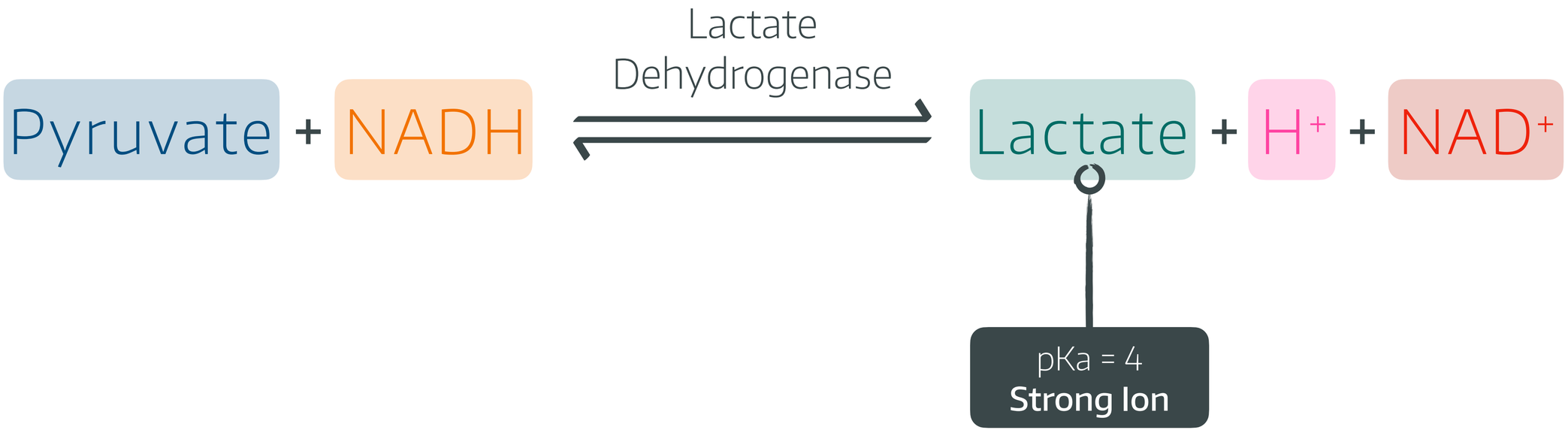
L Lactic Acidosis

E Ethylene Glycol
Ethanol

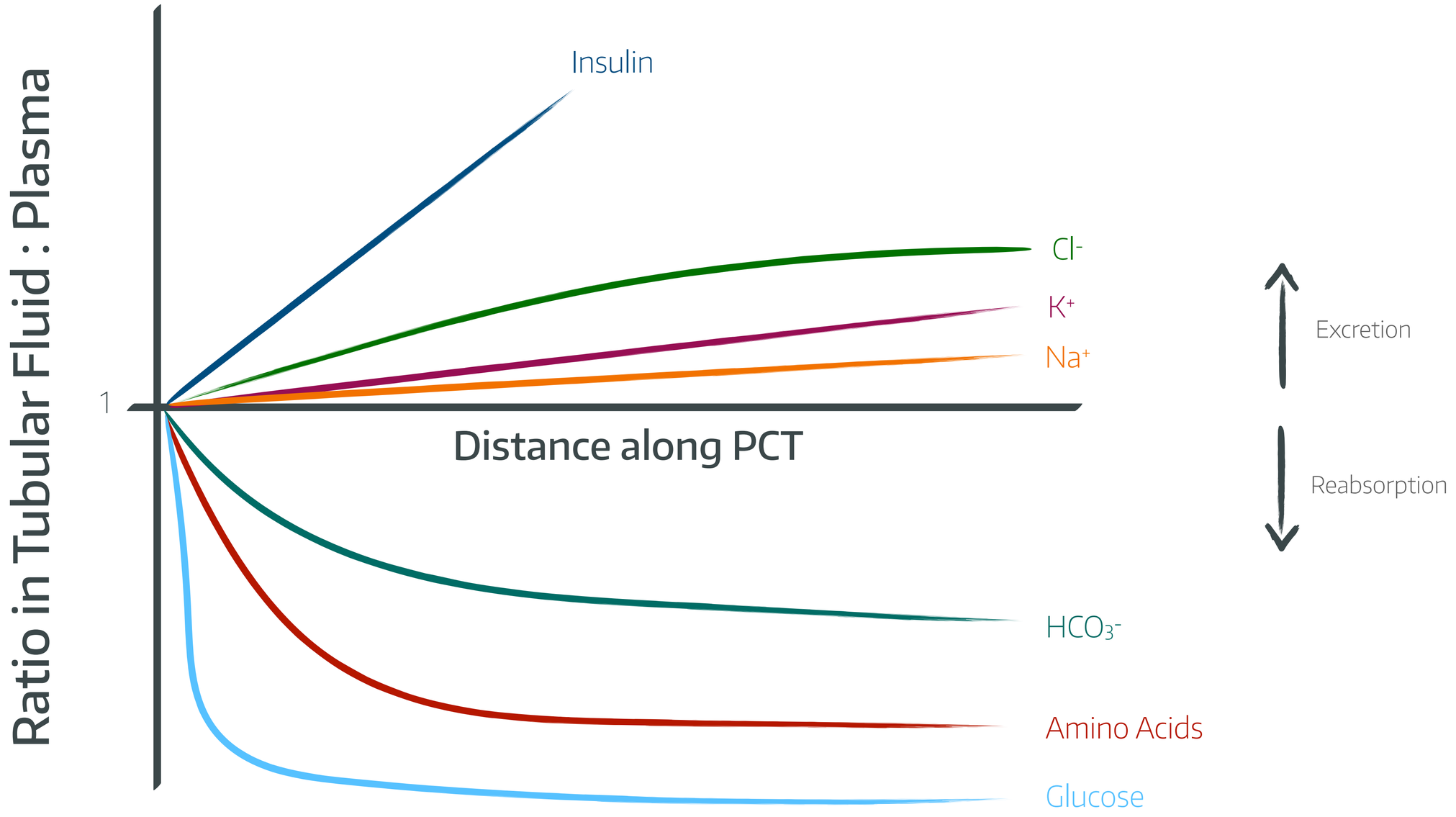
S Salicylates

ANION GAP = $([Na^+] + [K^+]) - ([Cl^-]+[HCO_3^-])$ | **‘Raised’: > 12mmol**

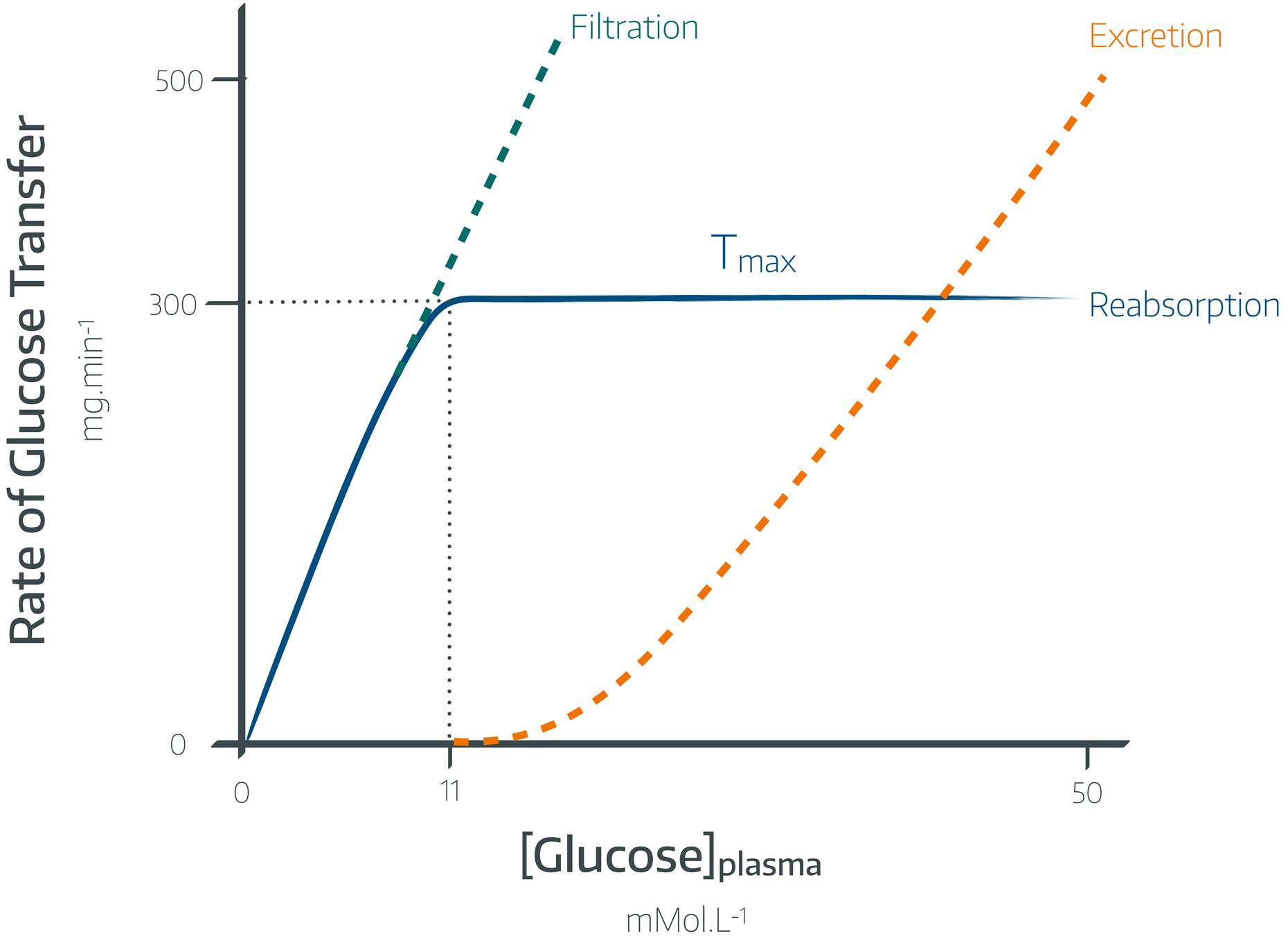
BIOCHEMISTRY



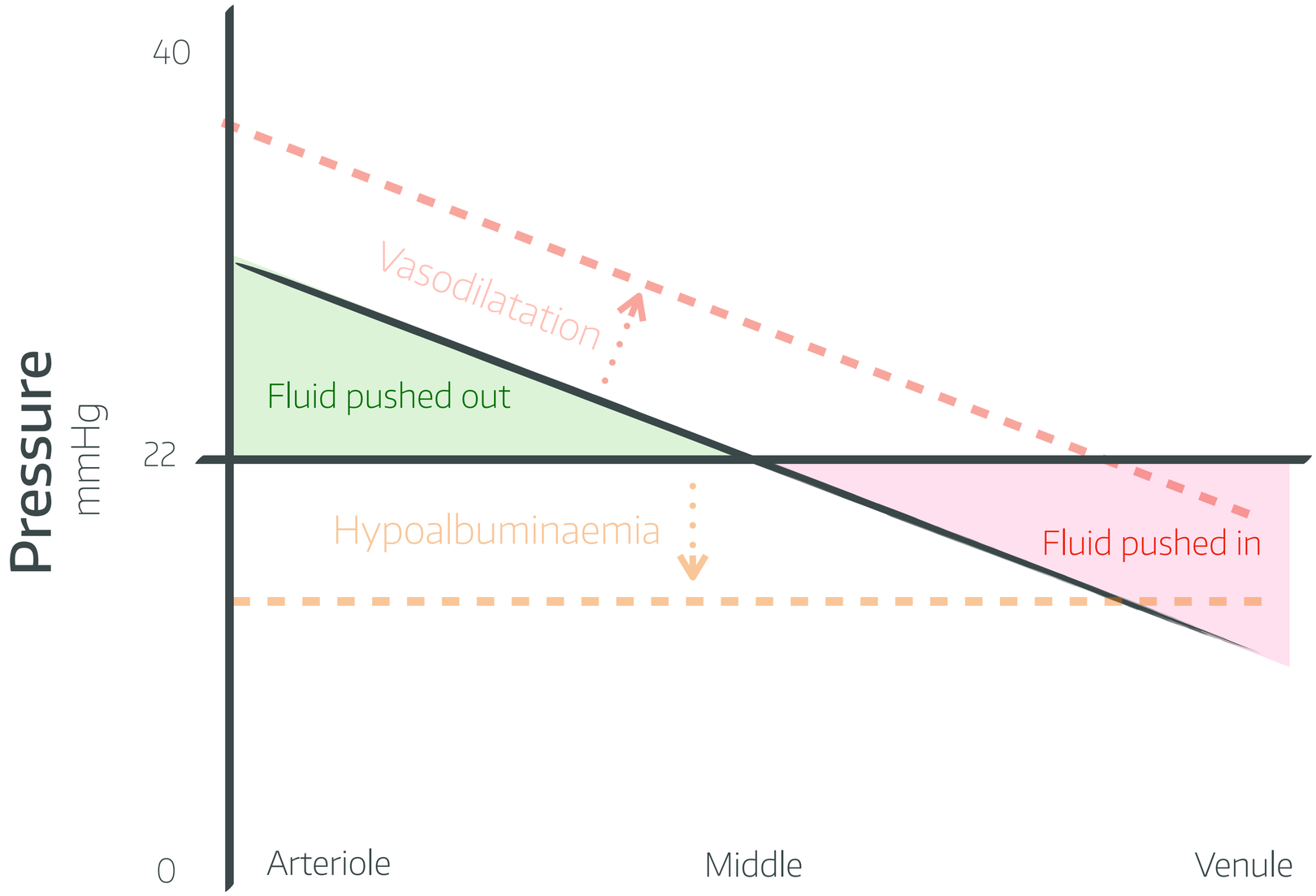
Renal Physiology



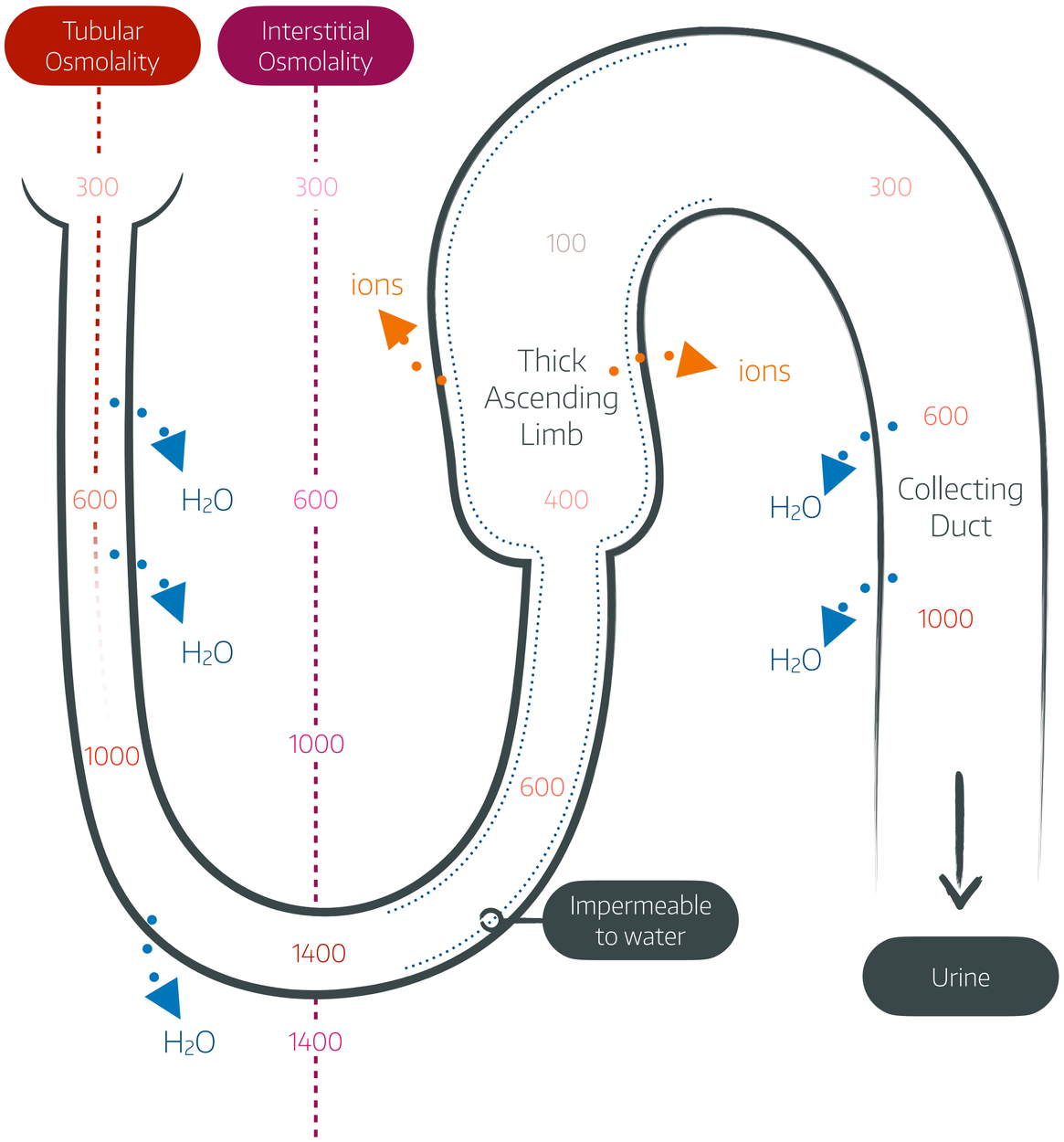
Renal Physiology



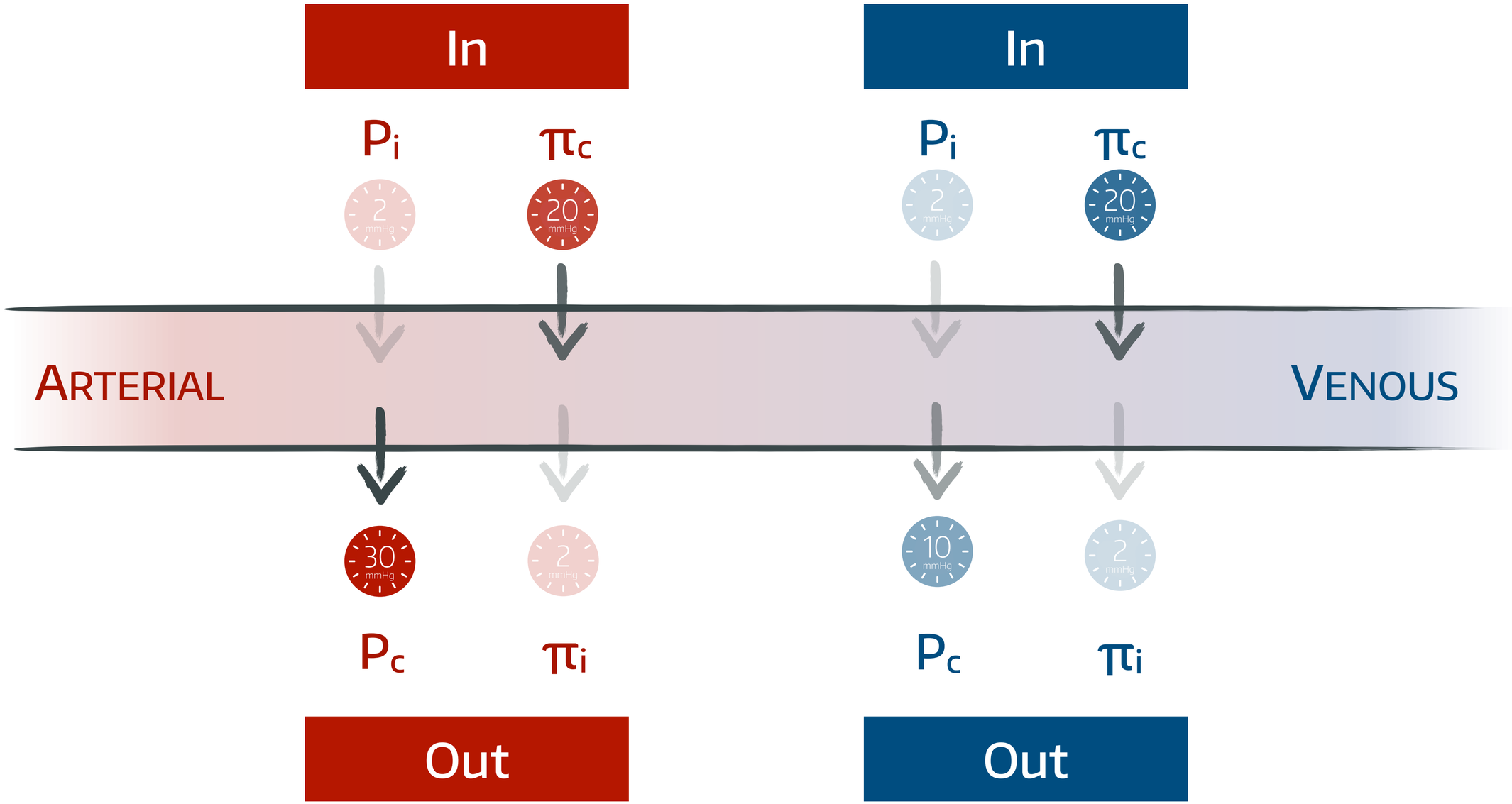
Renal Physiology



Renal Physiology



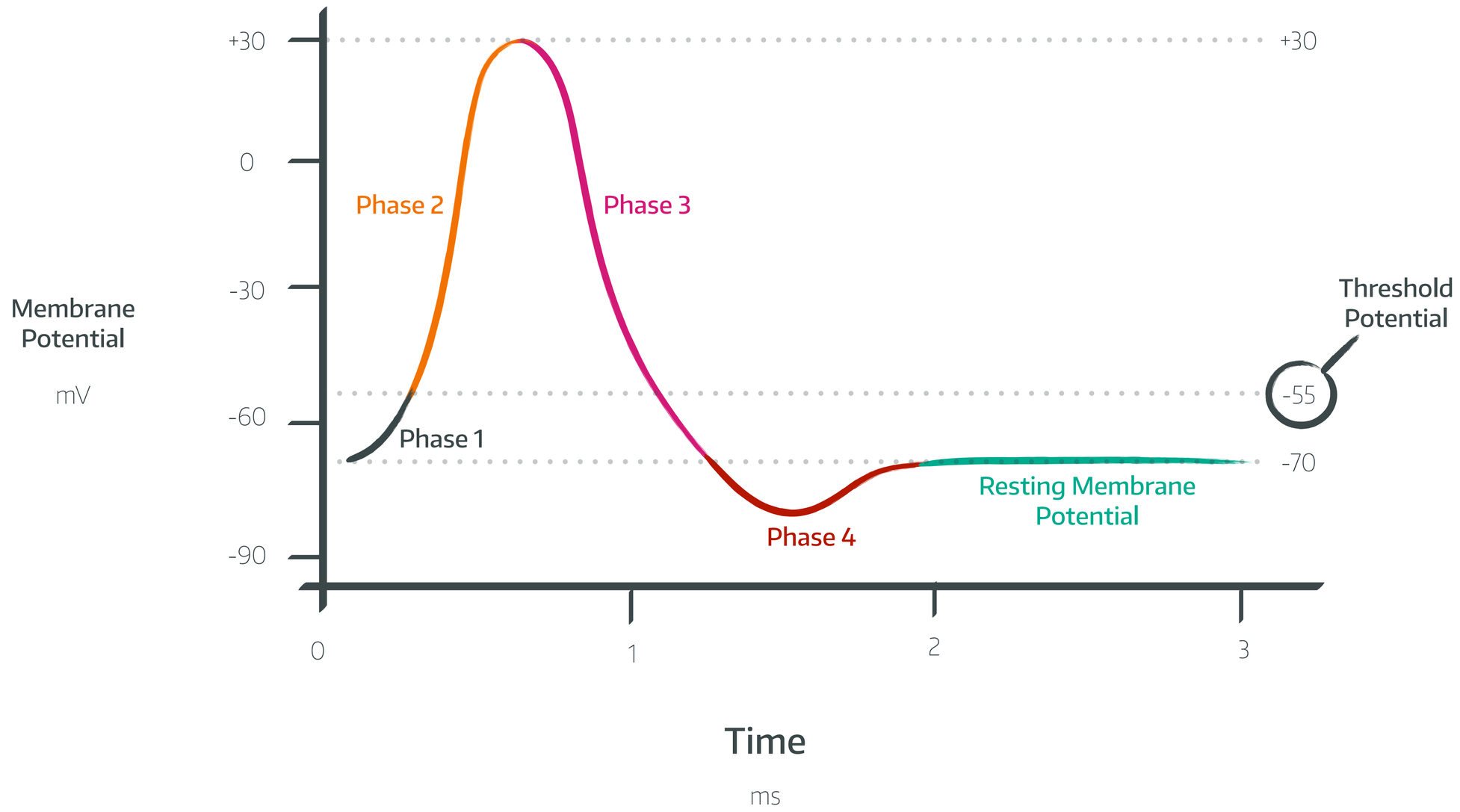
Starling Forces



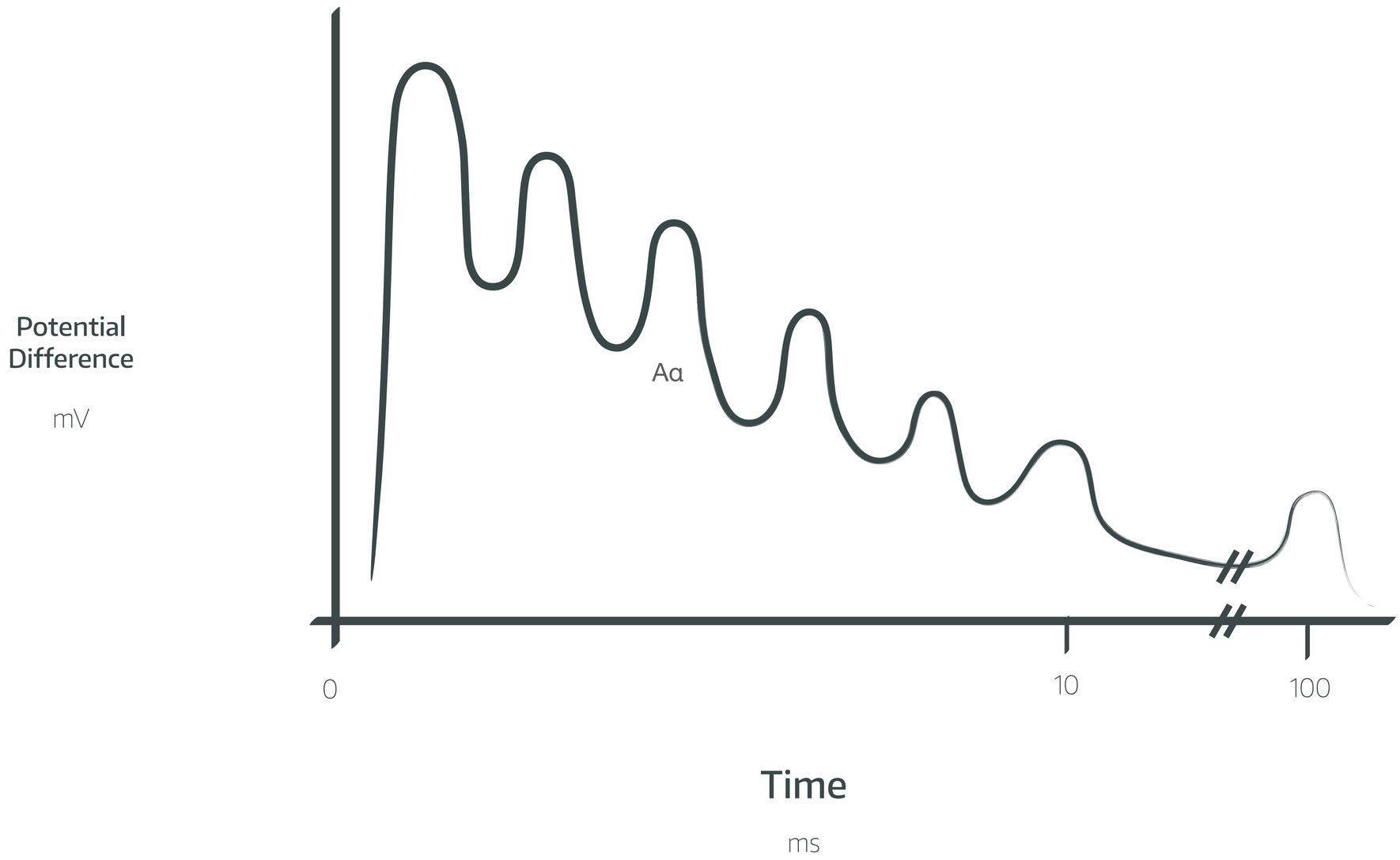
Net: 10mmHg out

Net: 10mmHg in

Neuronal Action Potential

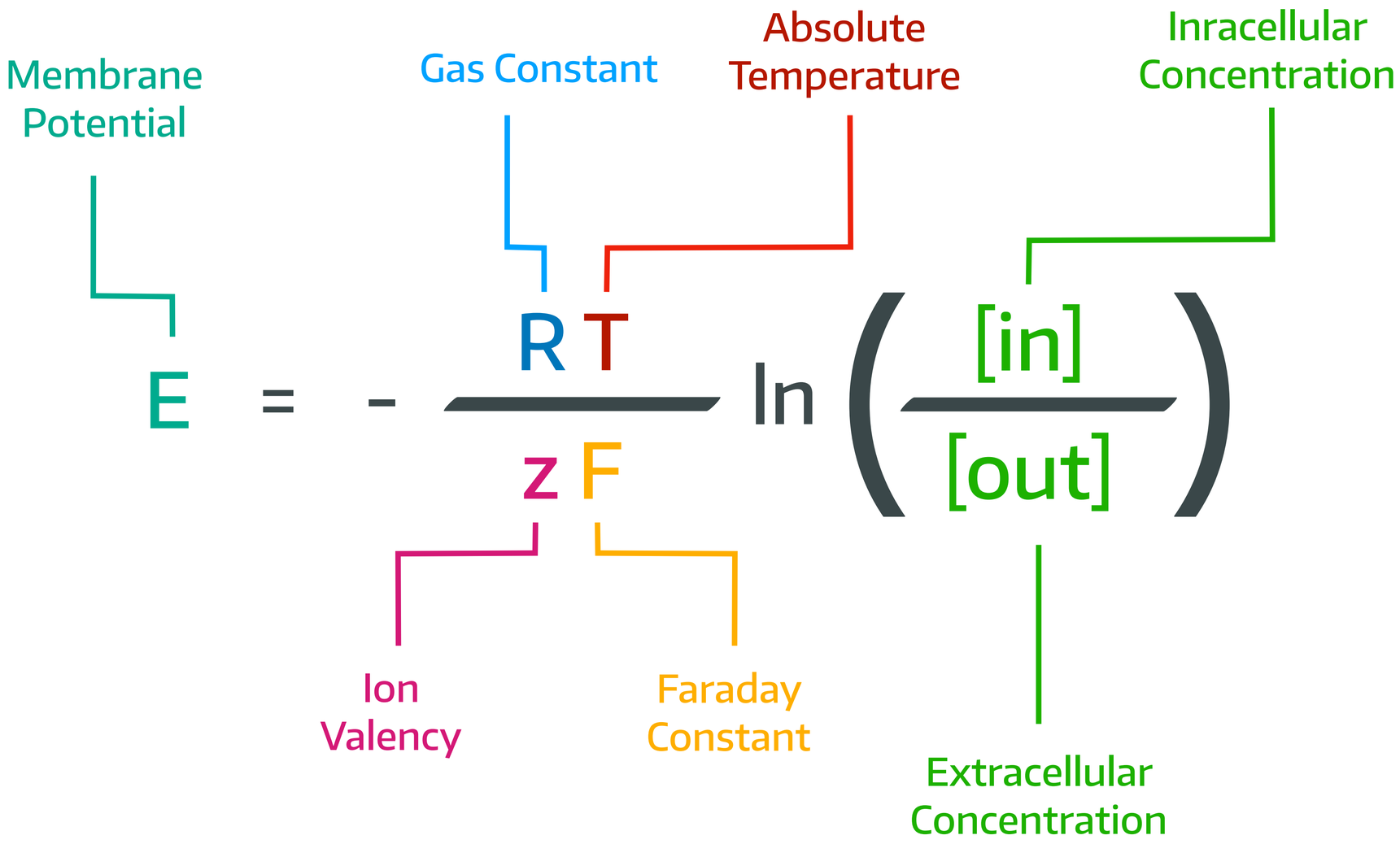


Neuronal Action Potential



Neurone Physiology

Nernst Equation



Neurone Physiology

Nernst Equation

$$E = -\frac{RT}{zF} \ln\left(\frac{[in]}{[out]}\right)$$

E.G. for potassium (K^+)

$$= -\frac{8.314 \times 310.15}{(+1) \times 96{,}485} \ln\left(\frac{150}{4.5}\right)$$

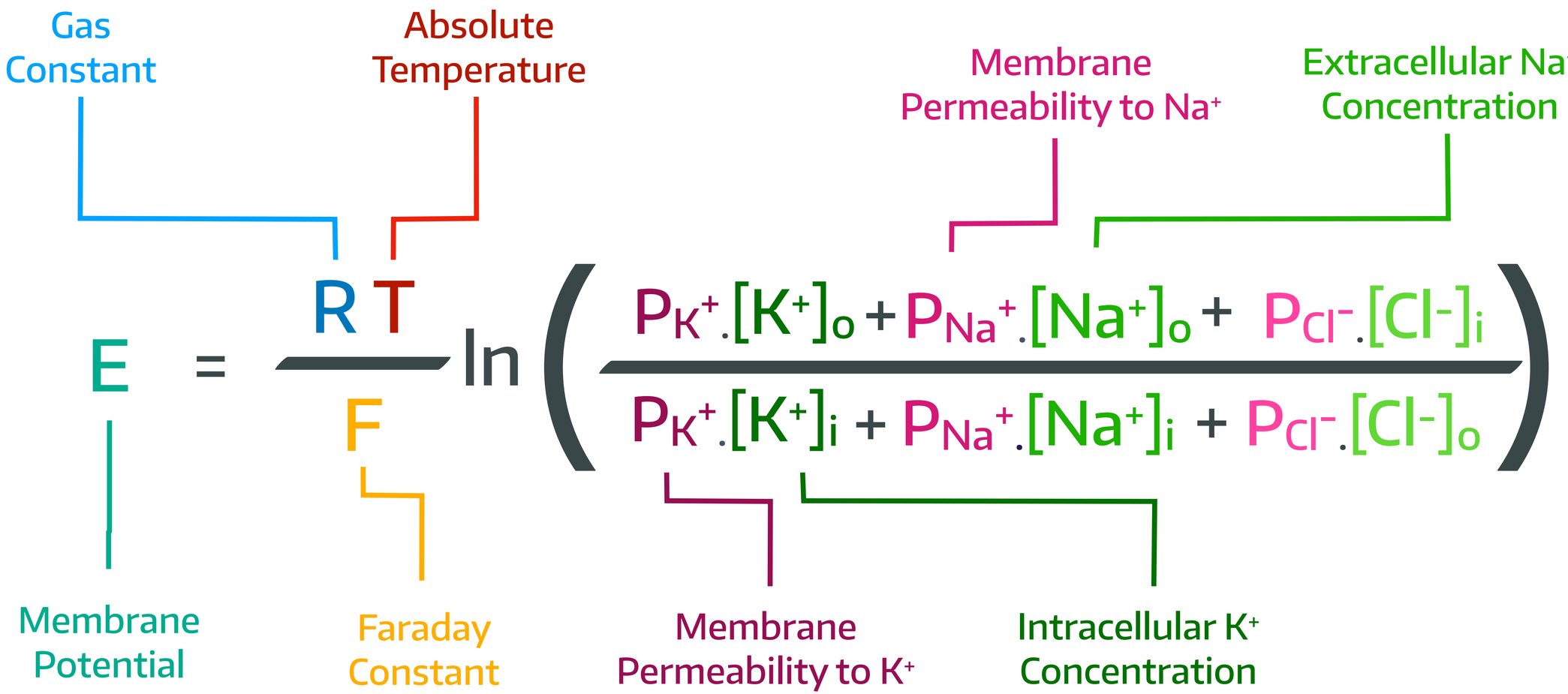
$$\approx -0.09V = -90mV$$

E.G. for Sodium (Na^+)

$$= -\frac{8.314 \times 310.15}{(+1) \times 96{,}485} \ln\left(\frac{12}{140}\right)$$

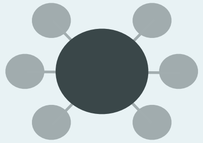
$$\approx +0.06V = +60mV$$

GOLDMAN EQUATION



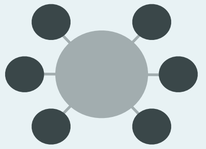
Nervous System

Central Nervous System



- Brain
  - Forebrain
  - Midbrain
  - Hindbrain
- Spinal Cord

Peripheral Nervous System



- Somatic
  - Sensory
  - Motor
- Autonomic
  - Sympathetic
  - Parasympathetic

Nervous System

Forebrain

Thalamus
Sleep

Hypothalamus
Metabolism
Homeostasis

Basal Ganglia
Voluntary Motor Control

Amygdala
Emotion
Fear
Memory

Hippocampus
Memory

Cortex
Higher thought
Language
Memory

Midbrain

Tectum
Eye & Ear Reflexes

Tegmentum
Movement
Cranial Nerve Nuclei

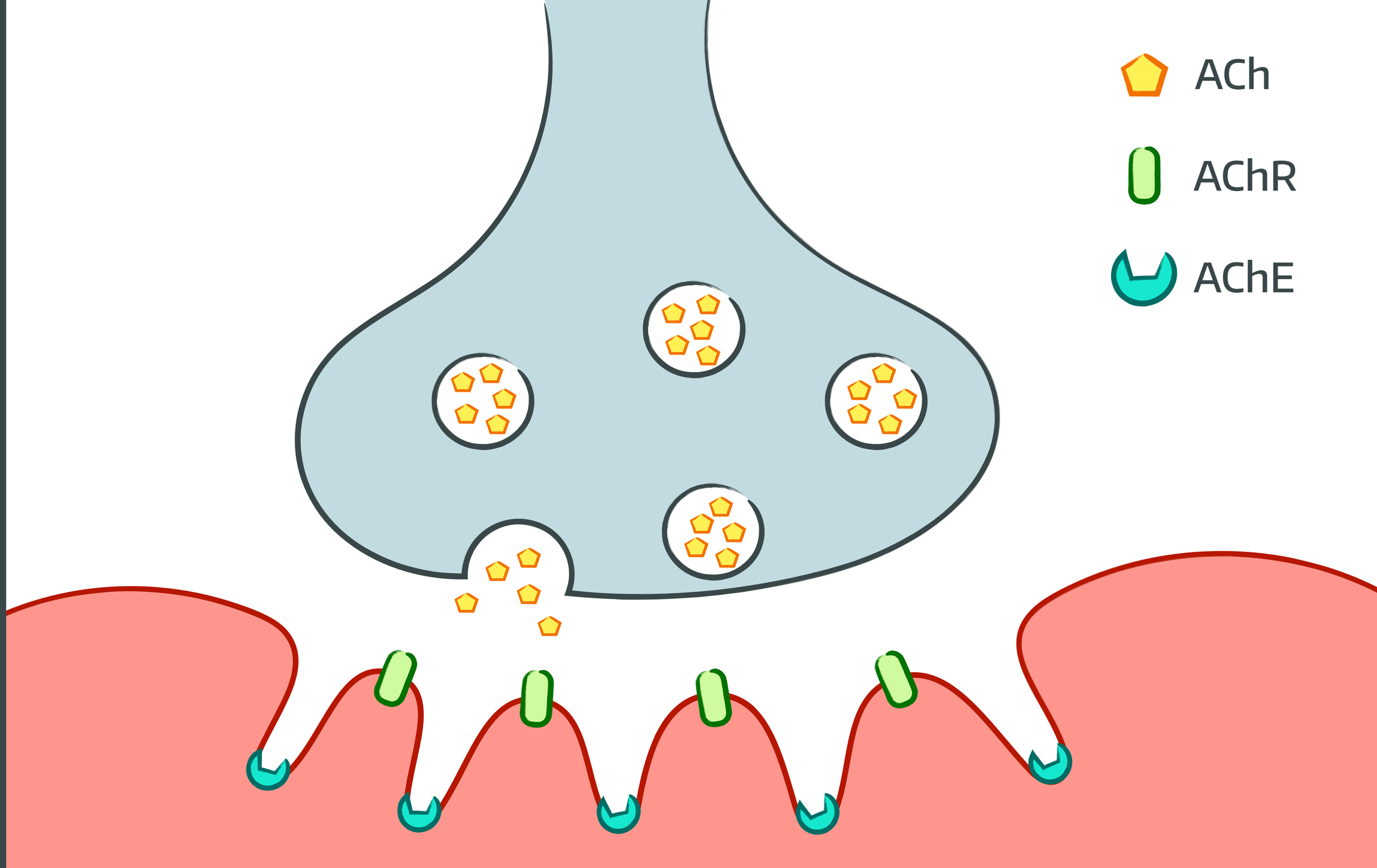
Hindbrain

Pons
Bladder
Sleep
Breathing
Swallowing

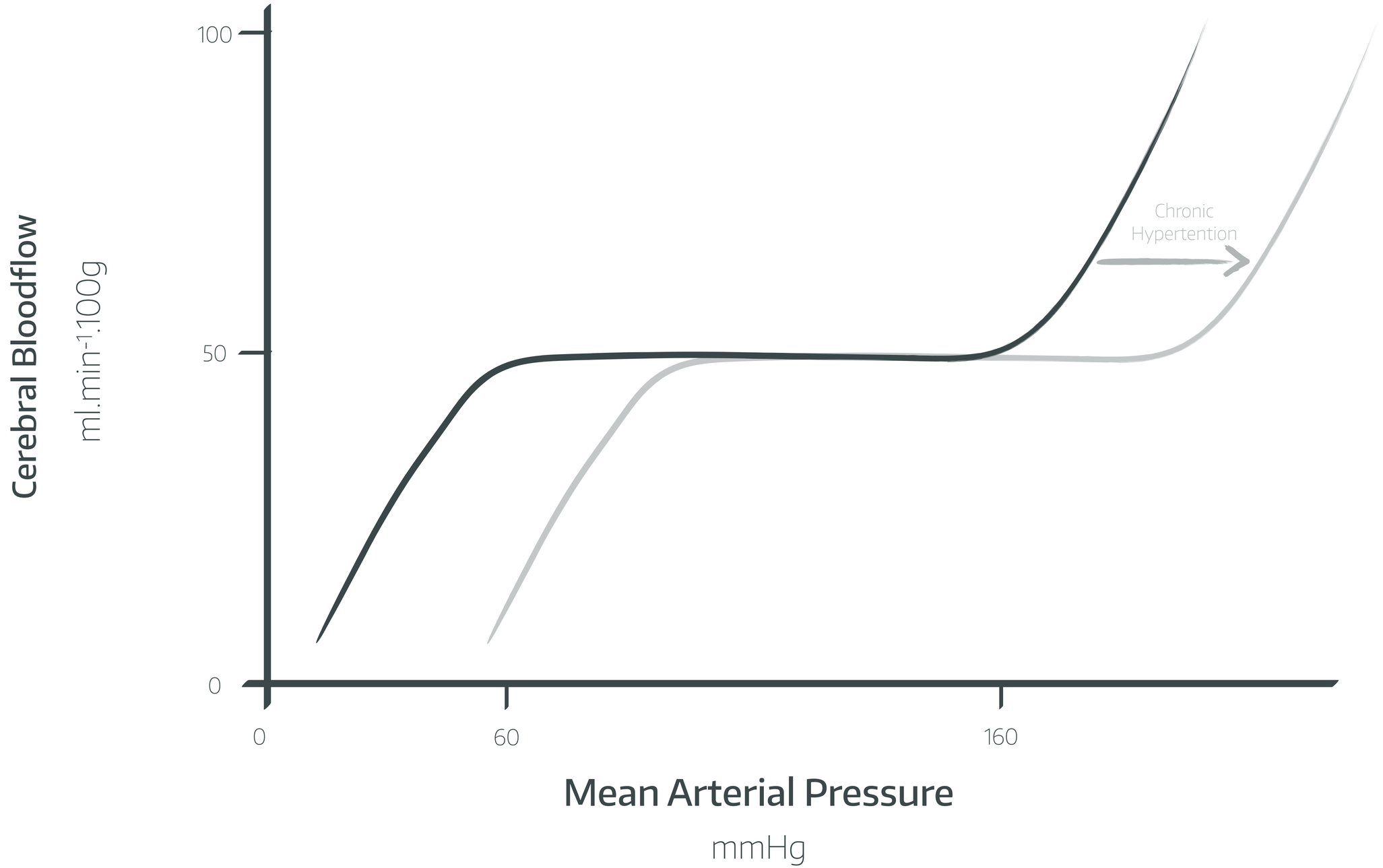
Medulla
Breathing
Heart & Circulation
Vomiting

Cerebellum
Balance
Co-ordination

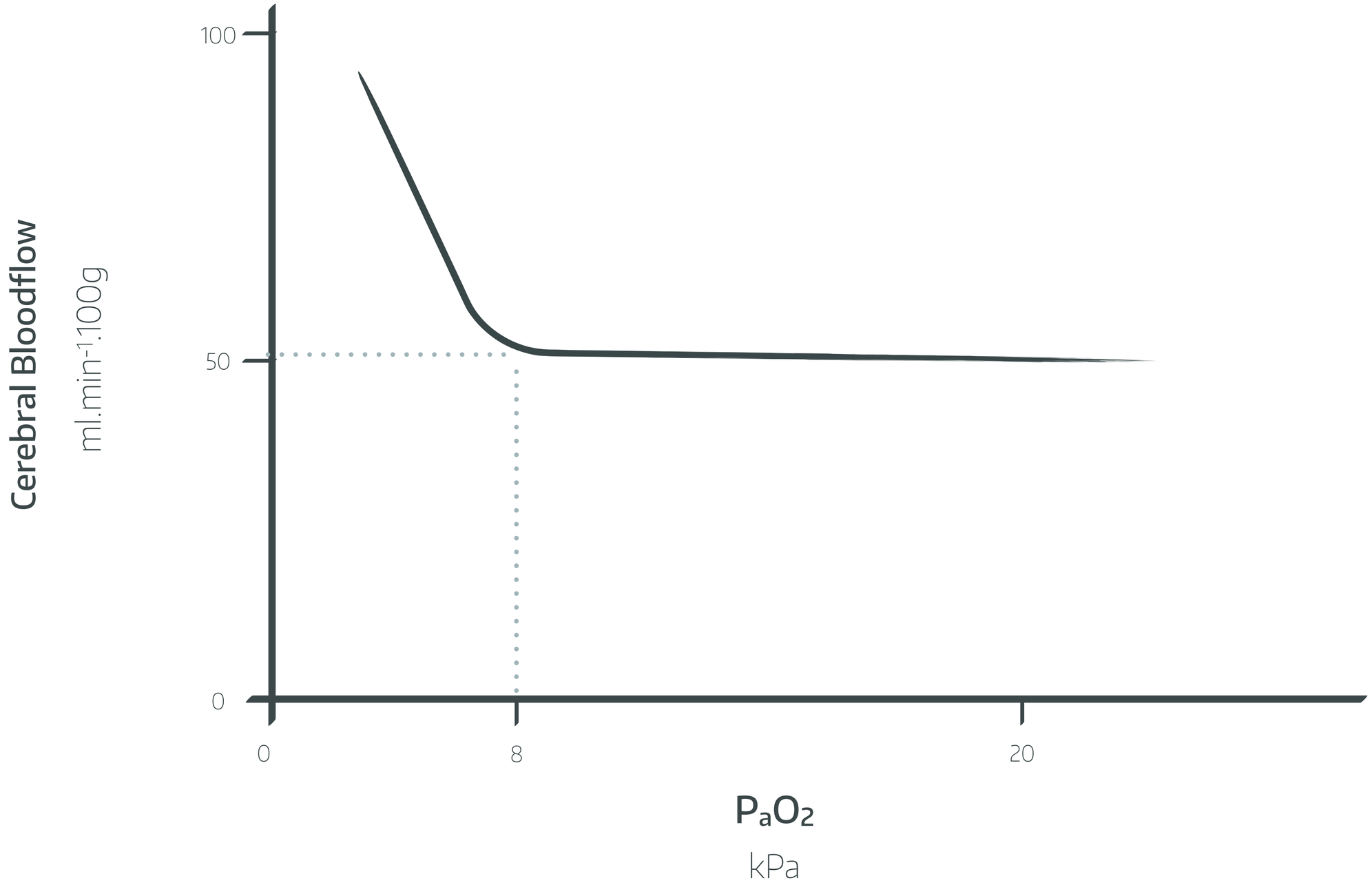
Neuromuscular Junction



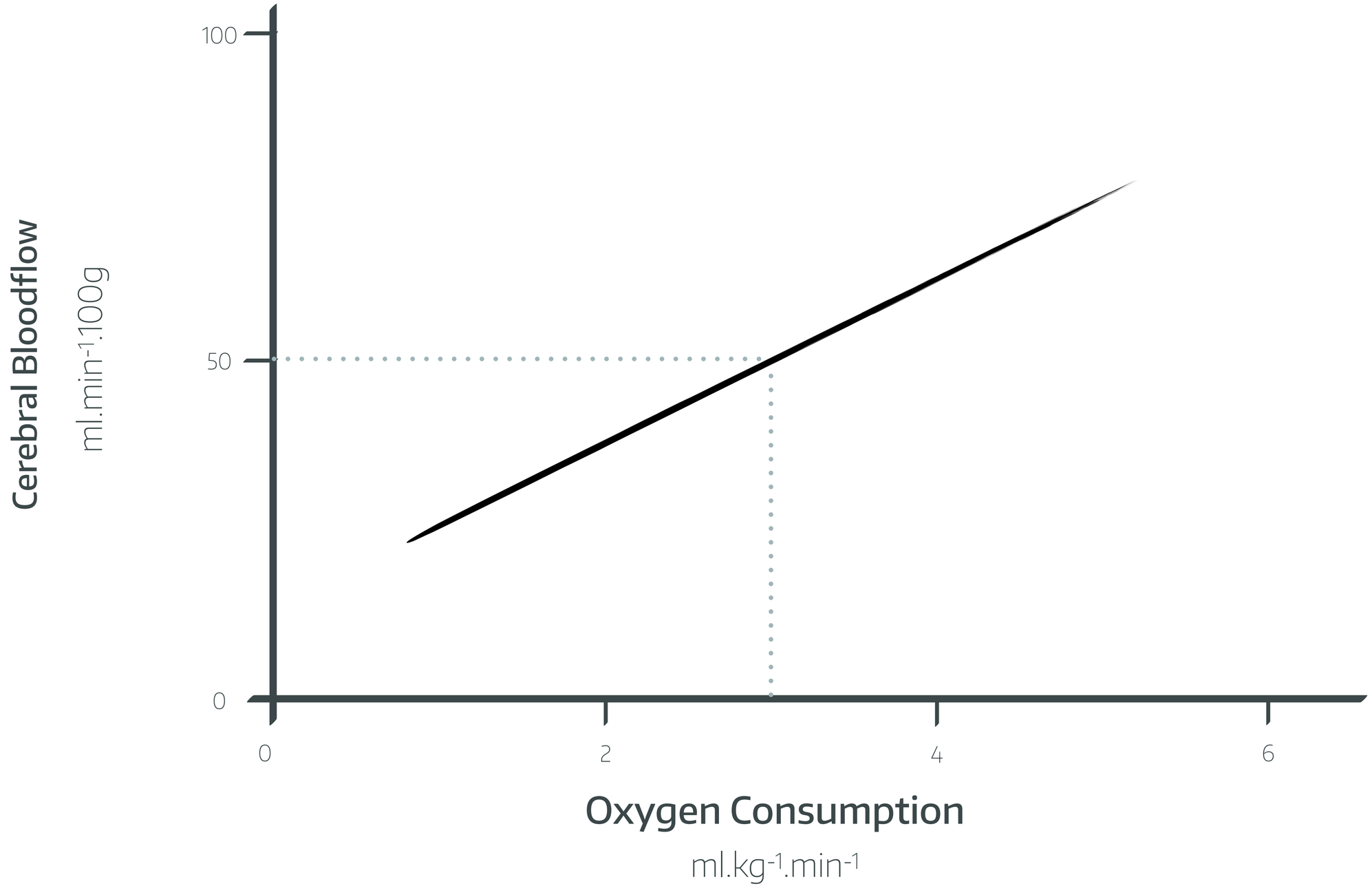
Cerebral Bloodflow



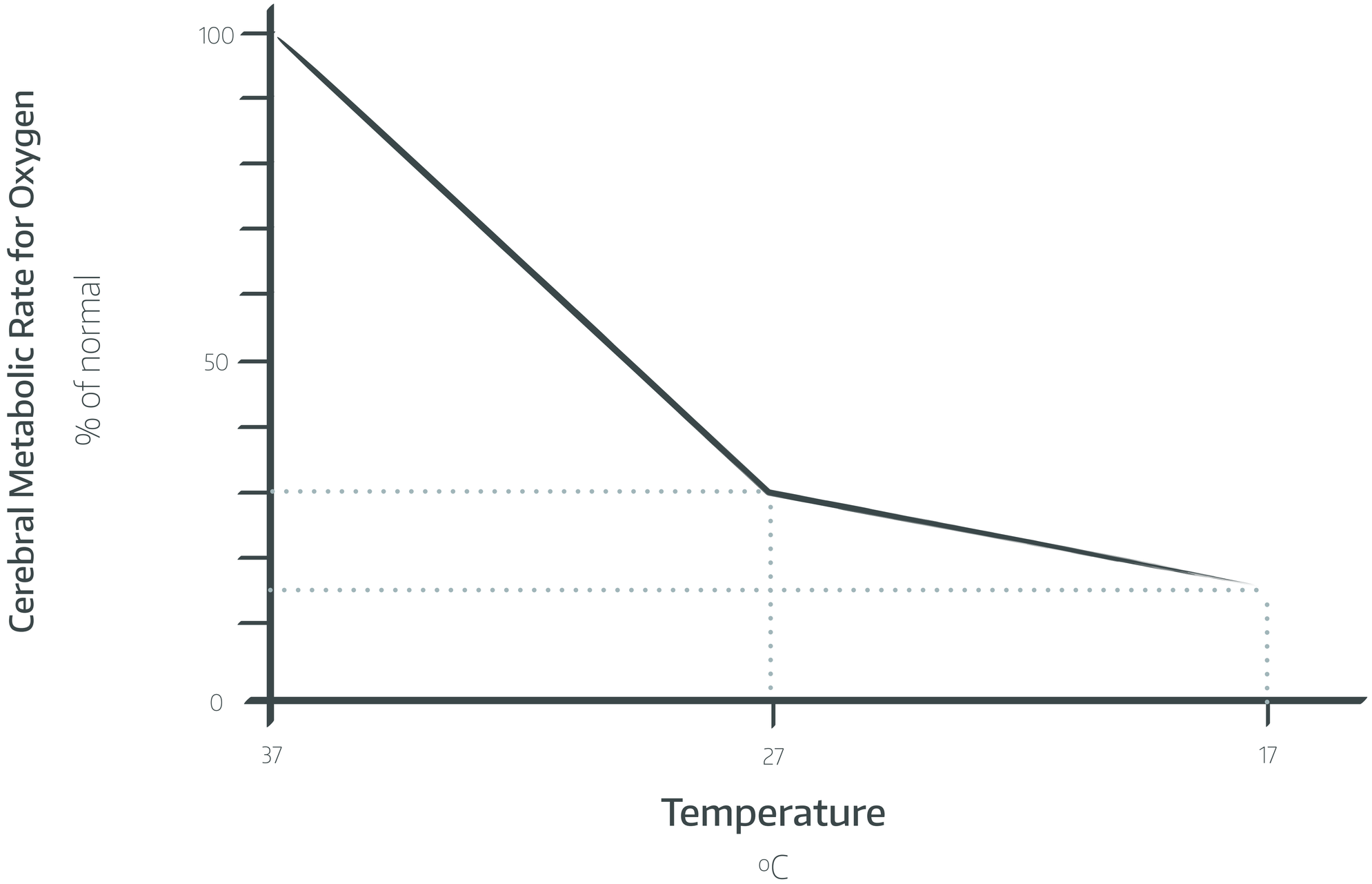
Cerebral Bloodflow



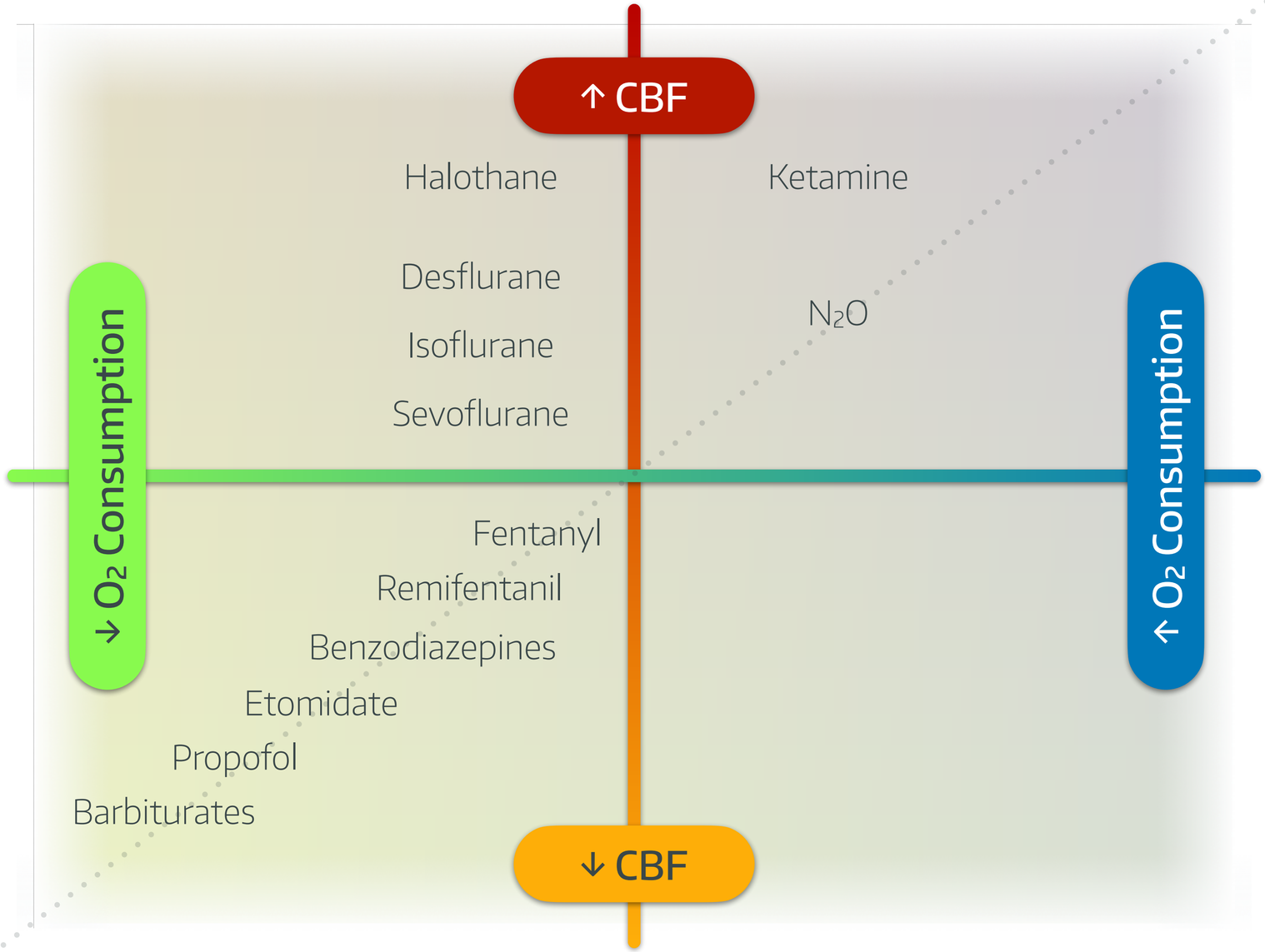
Cerebral Bloodflow



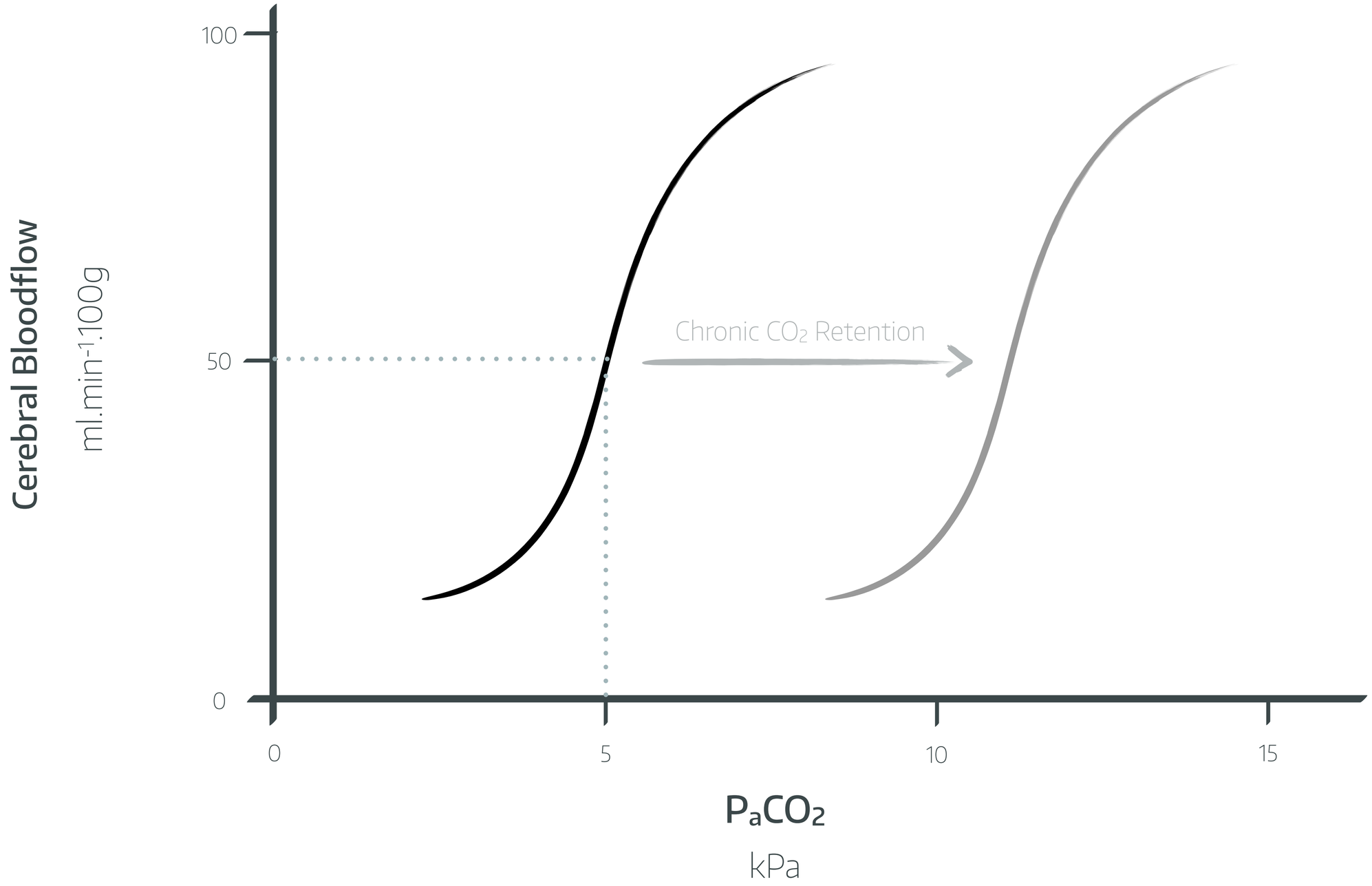
Cerebral Metabolic Rate



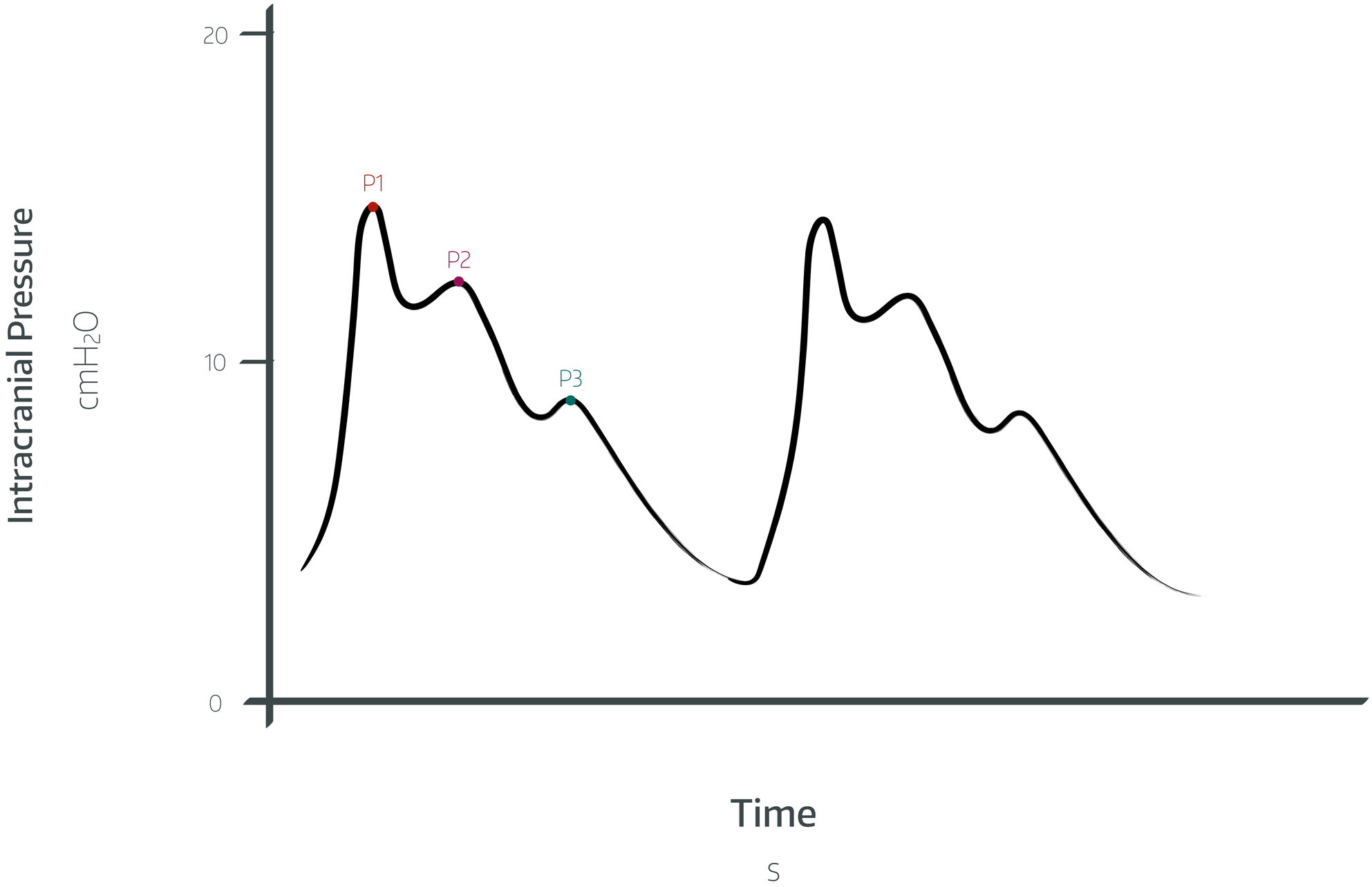
Cerebral Metabolic Rate



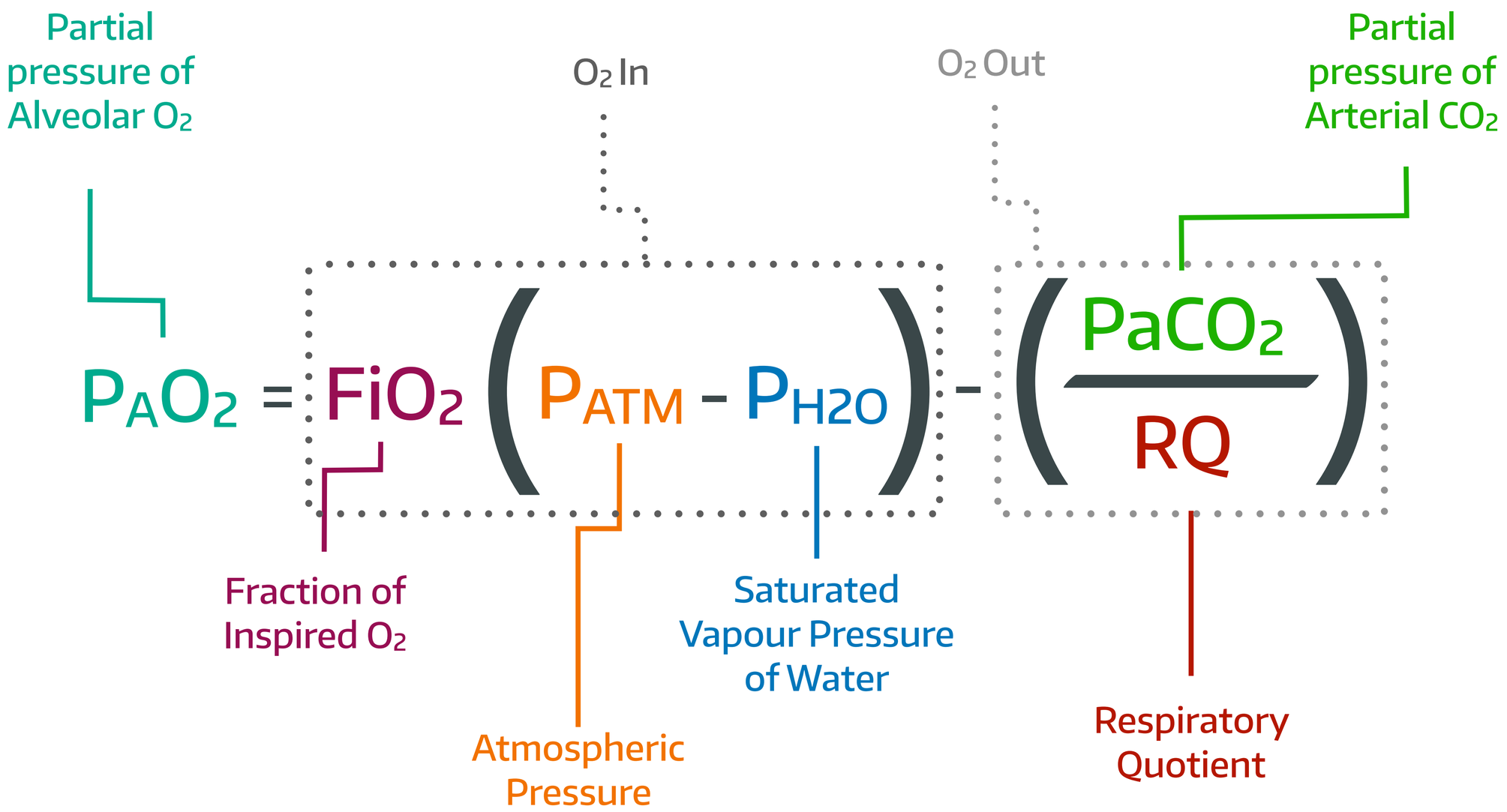
Cerebral Bloodflow



Intracranial Pressure



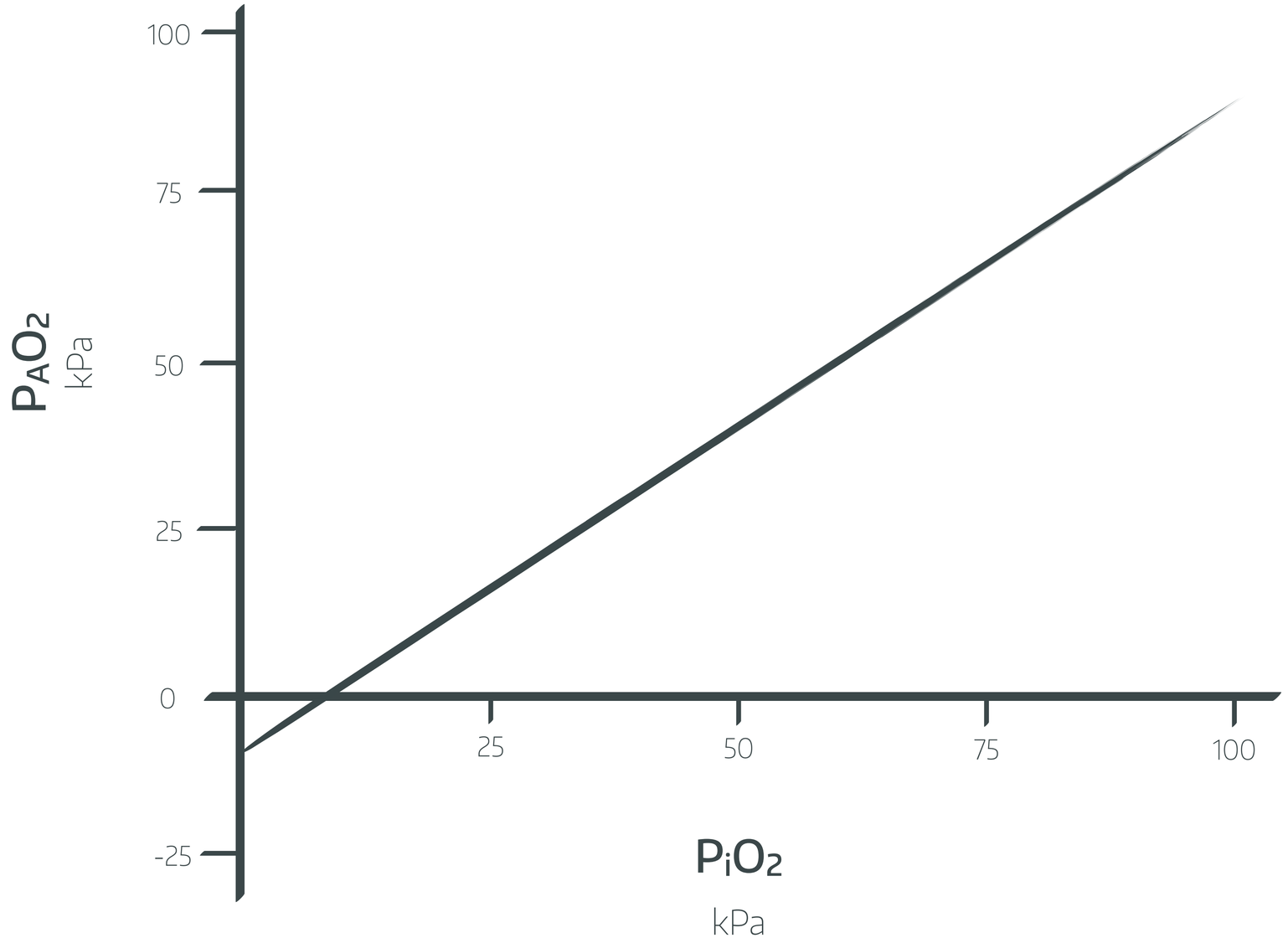
ALVEOLAR GAS EQUATION



Oxygenation

Alveolar Gas

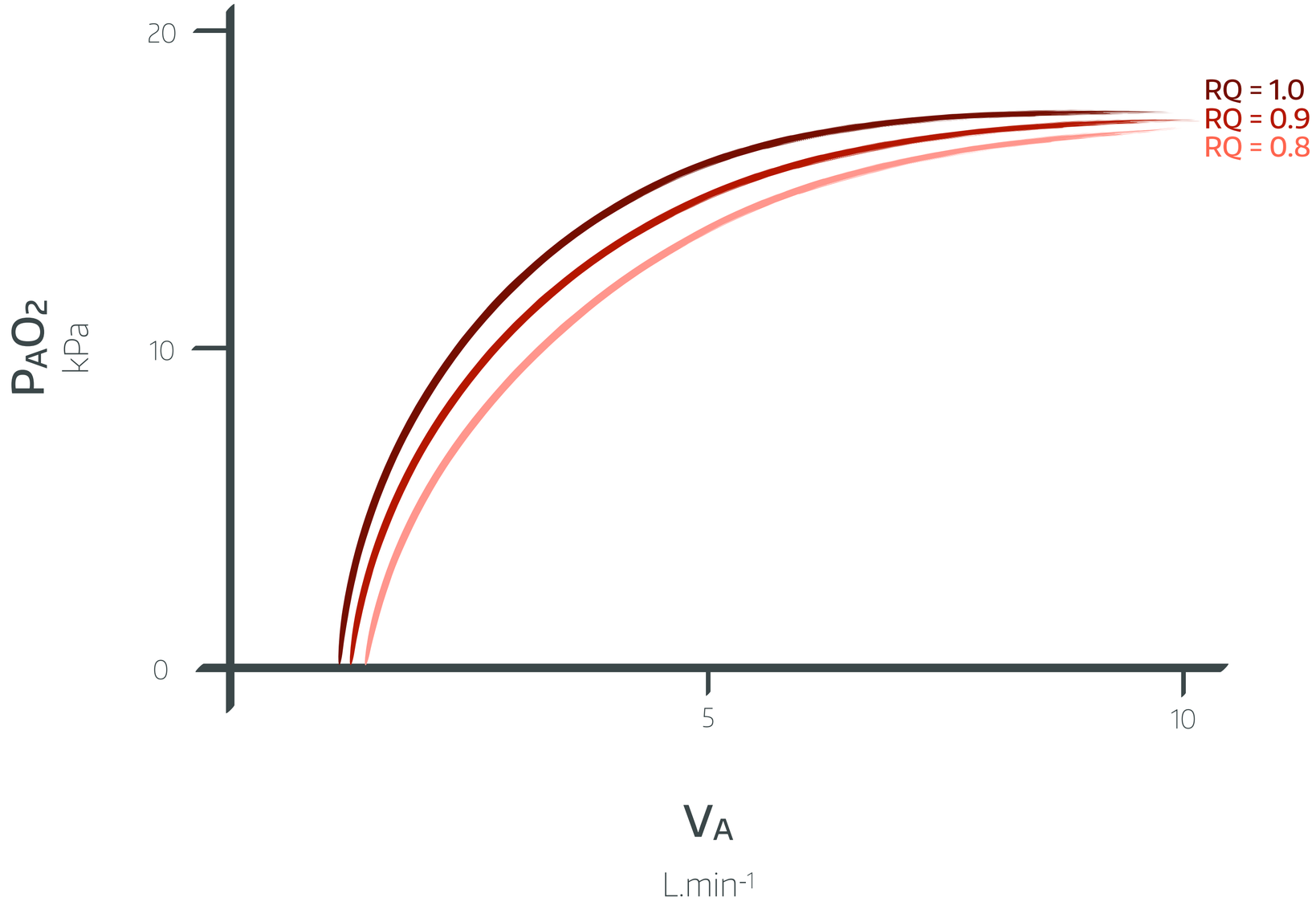
Arterial



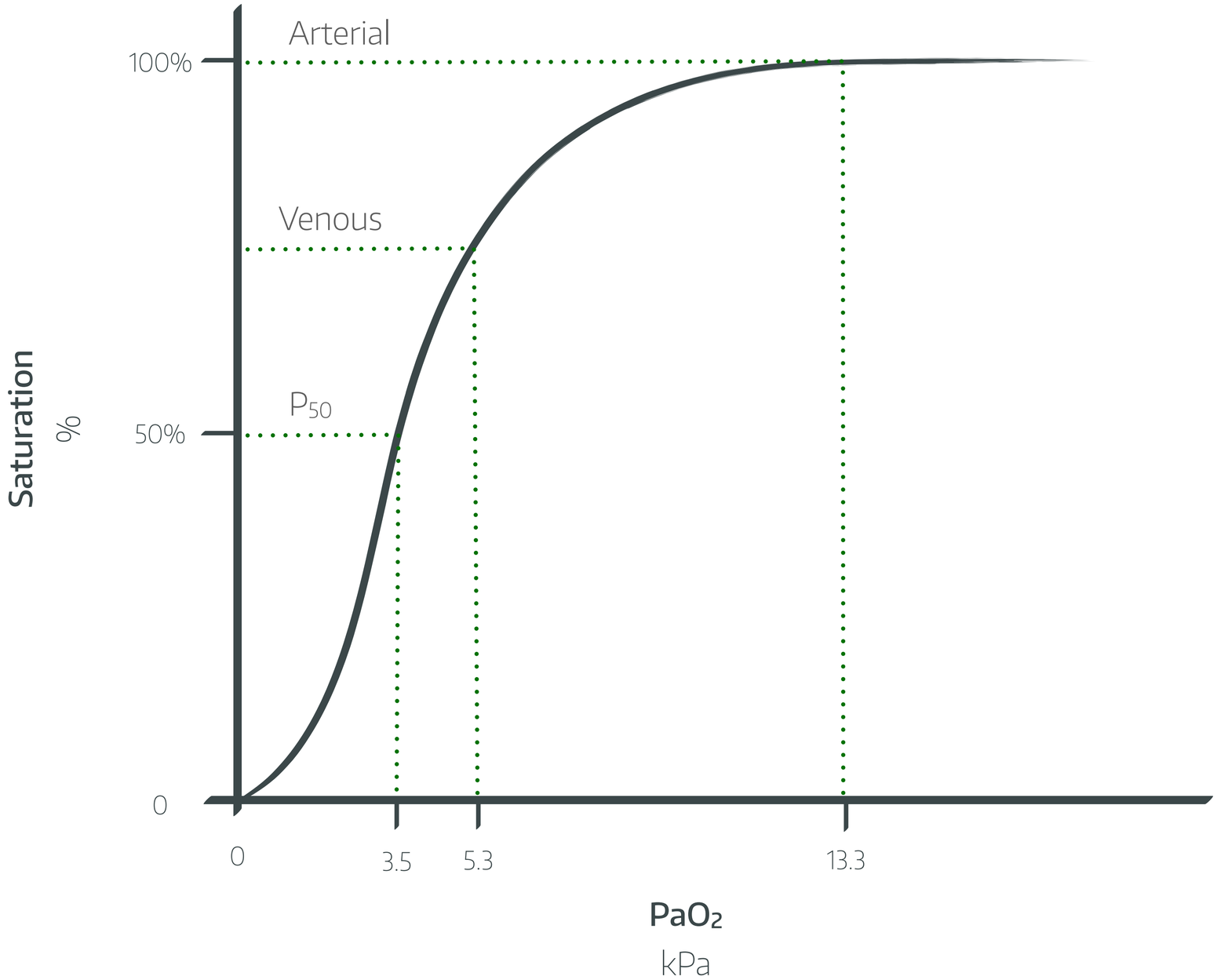
Oxygenation

Alveolar Gas

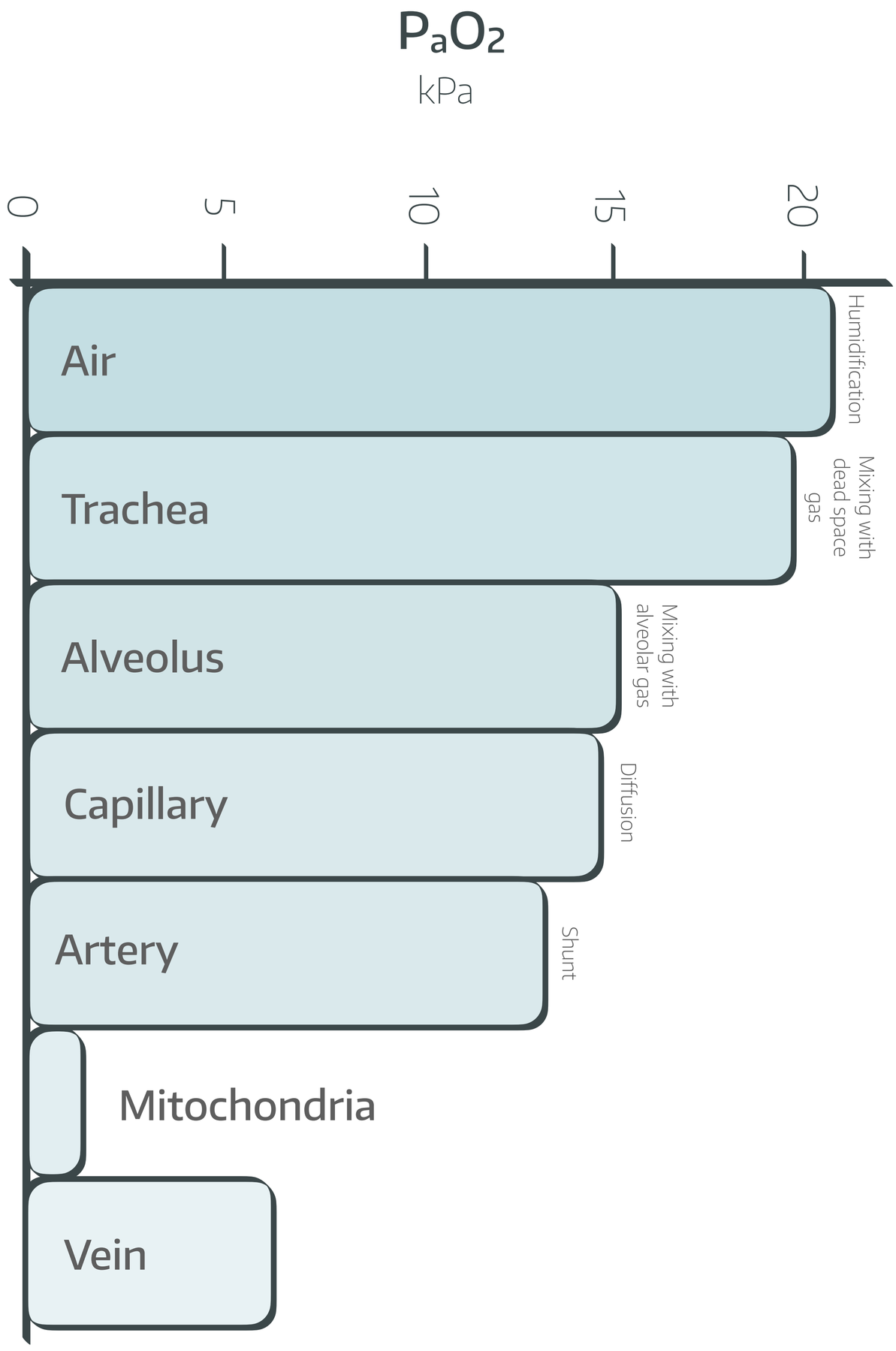
Arterial



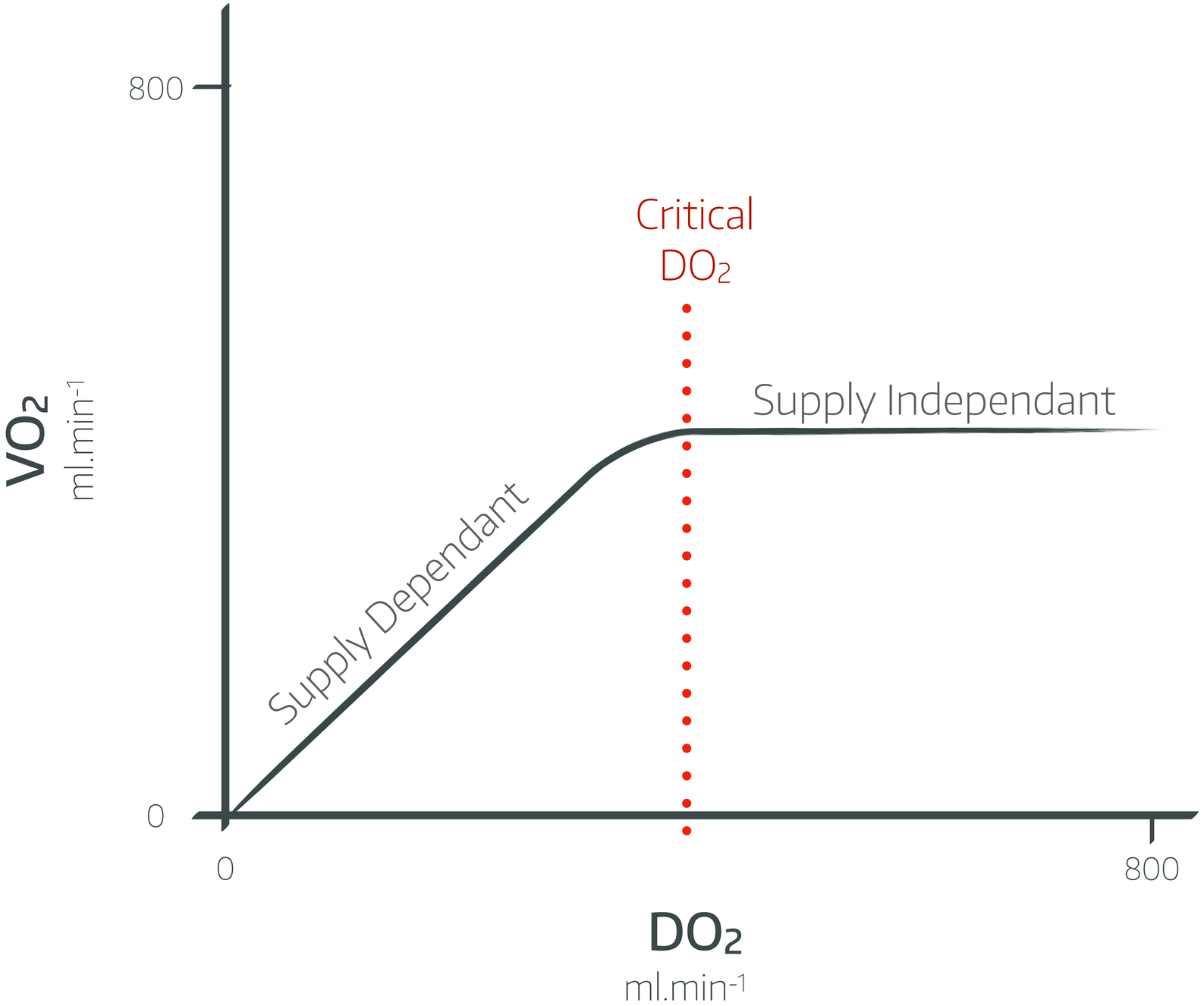
Oxygen Transport



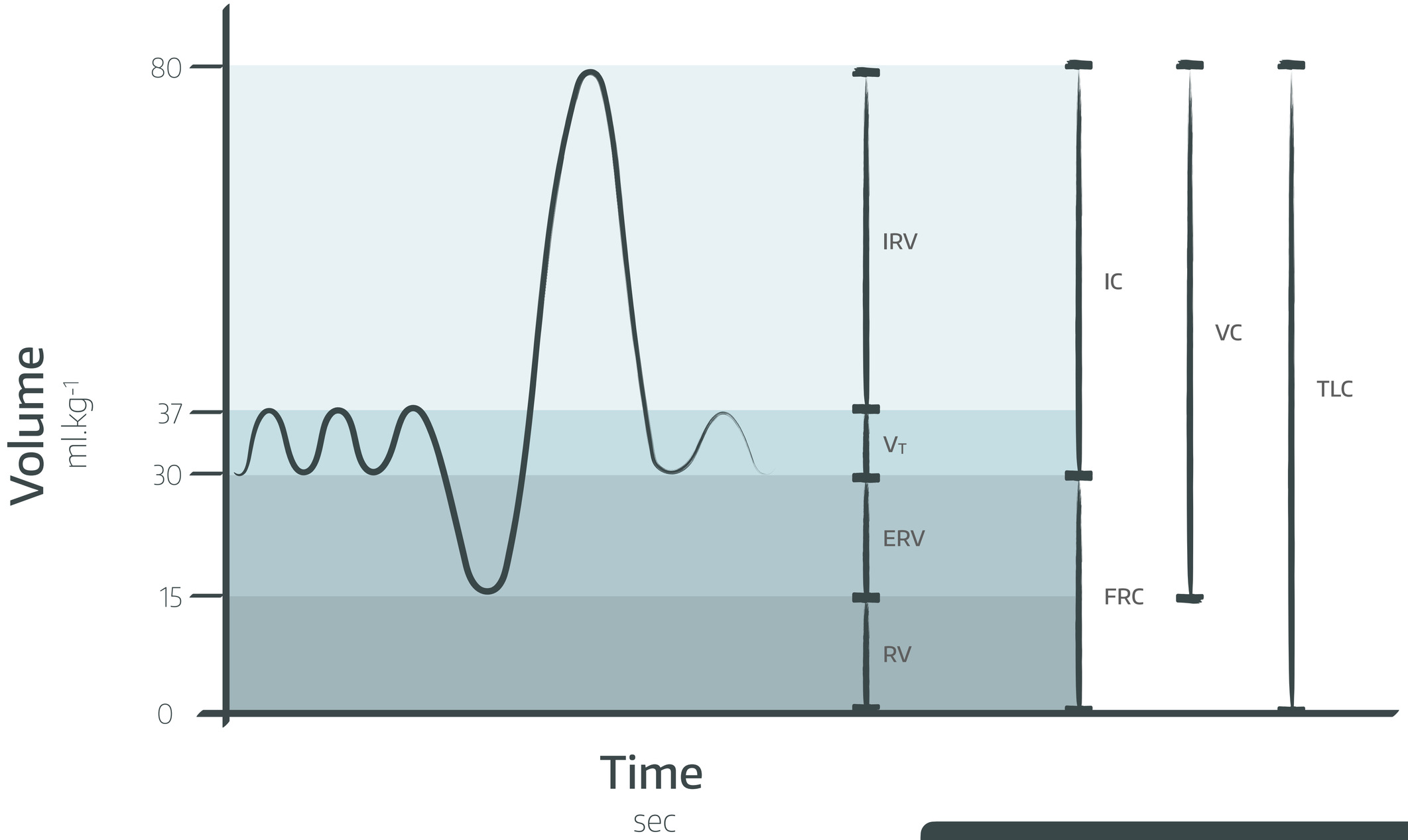
Oxygen Transport



Oxygen Transport

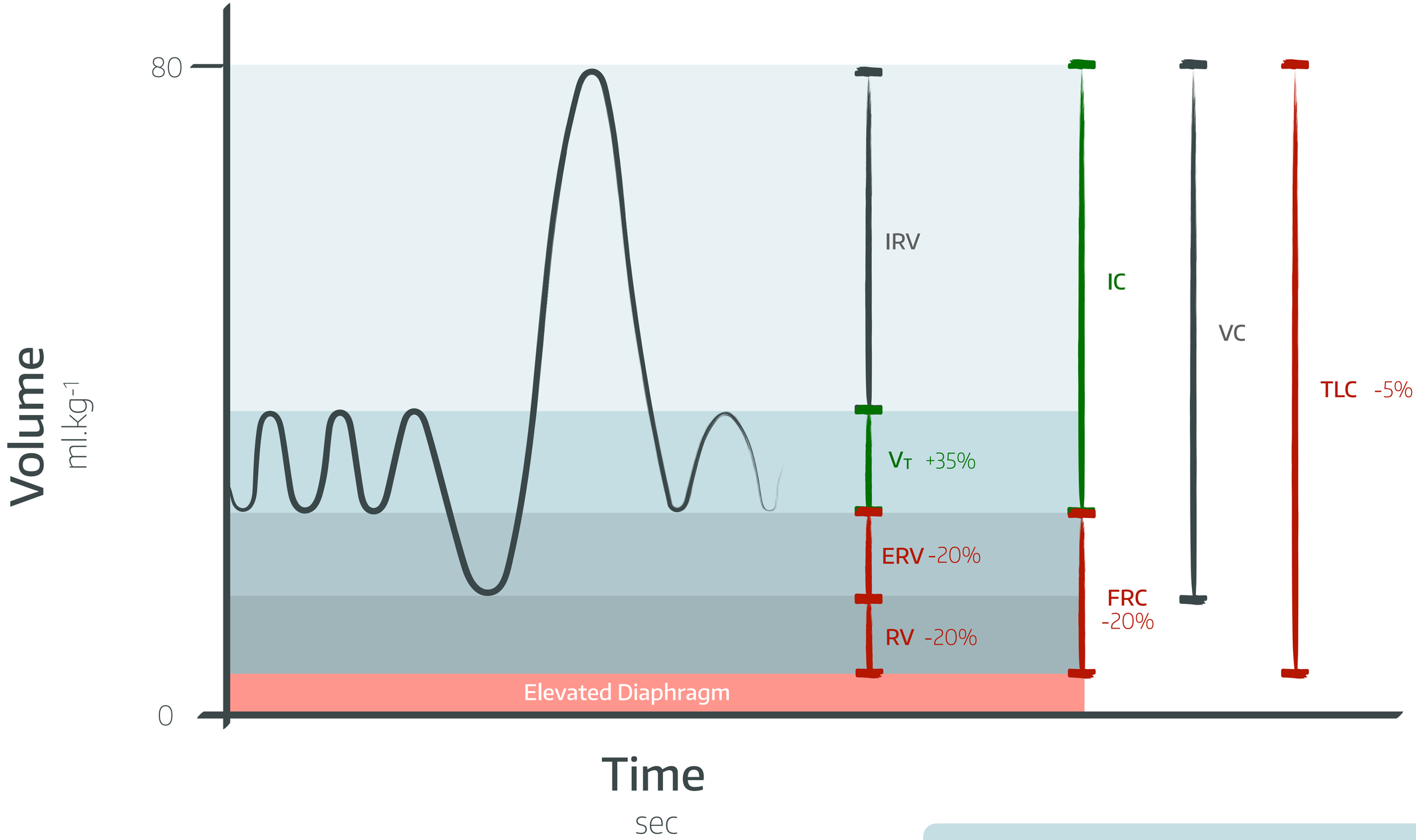


Respiratory Function



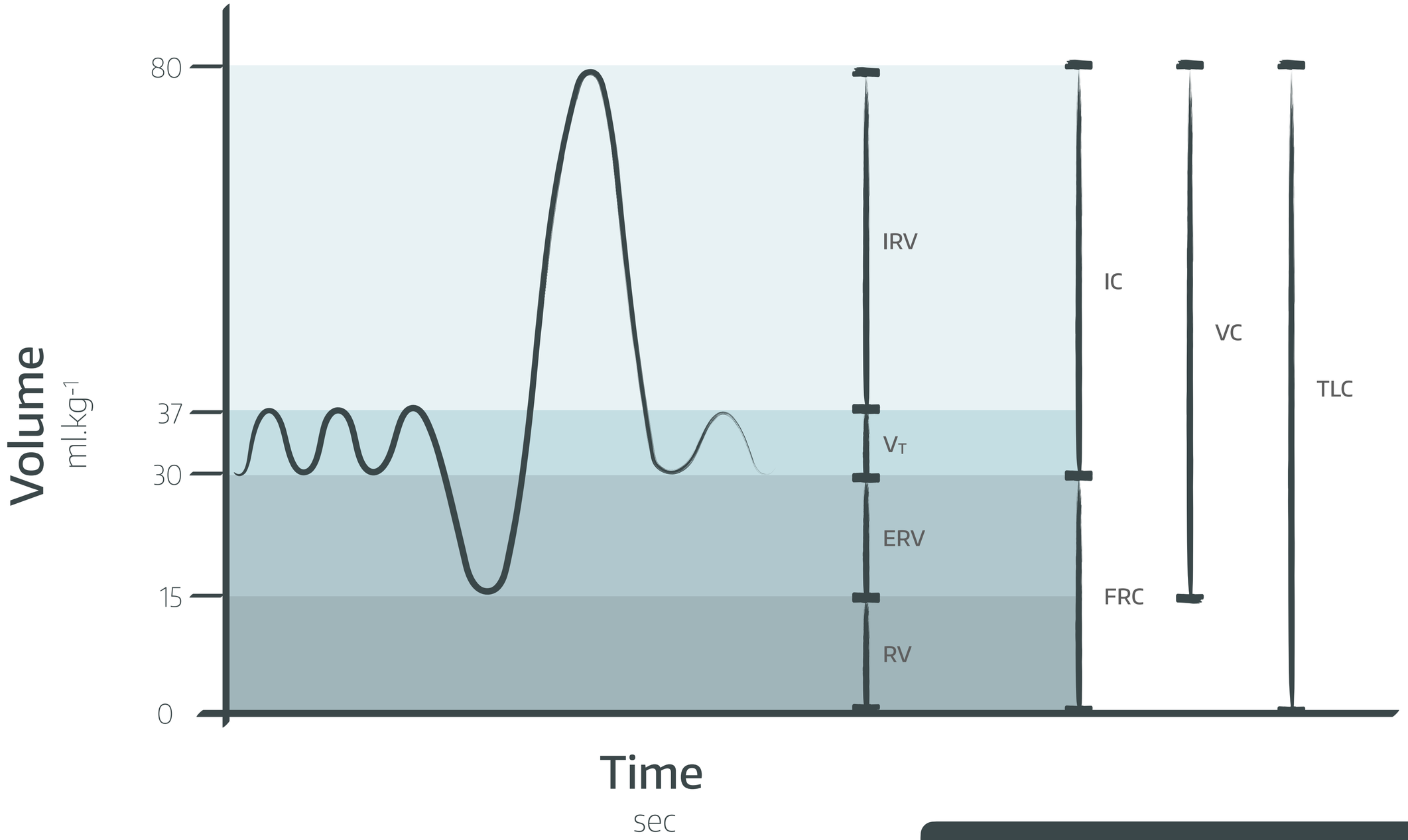
Not Pregnant

Respiratory Function



Pregnant

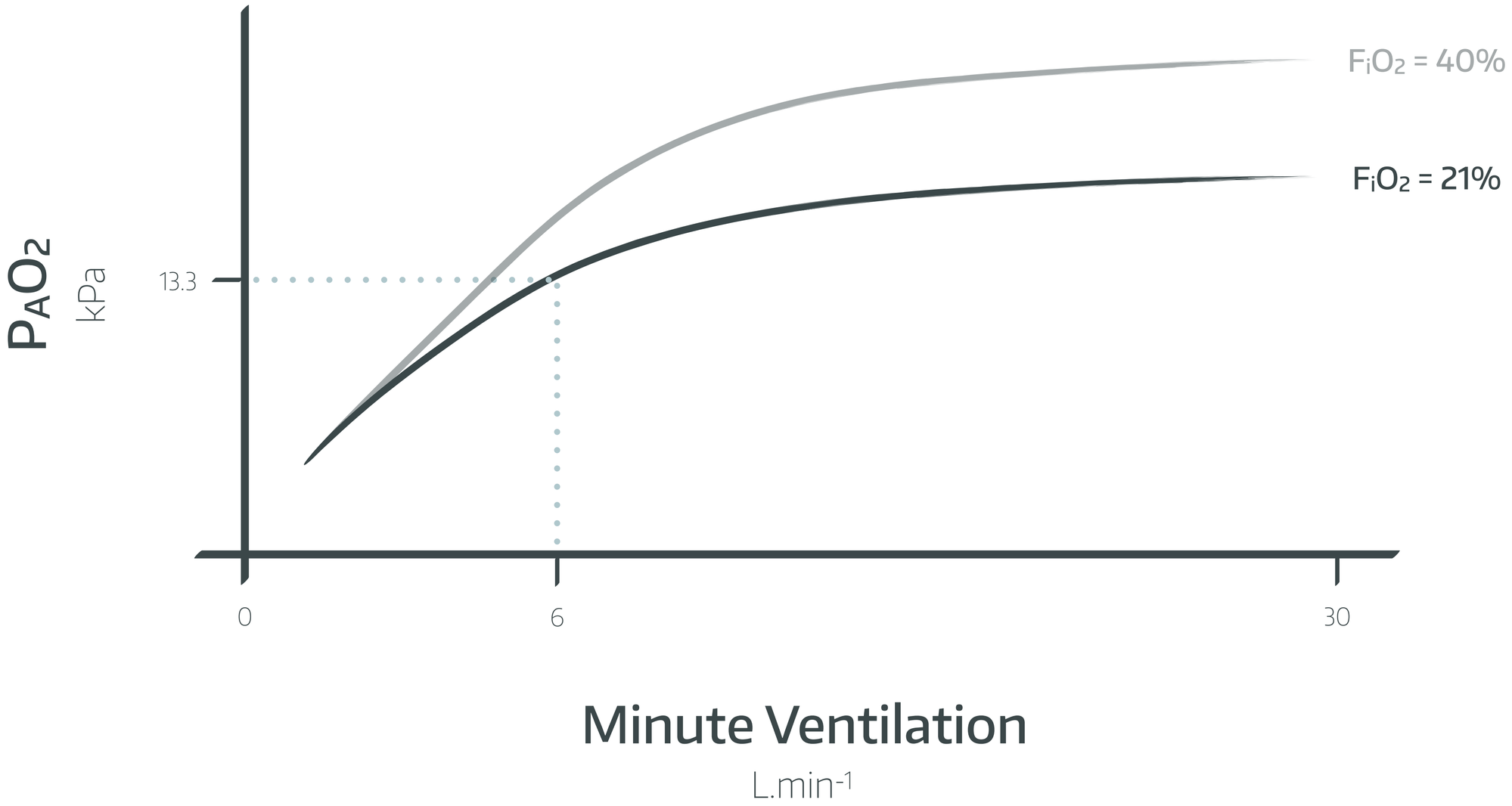
Respiratory Function



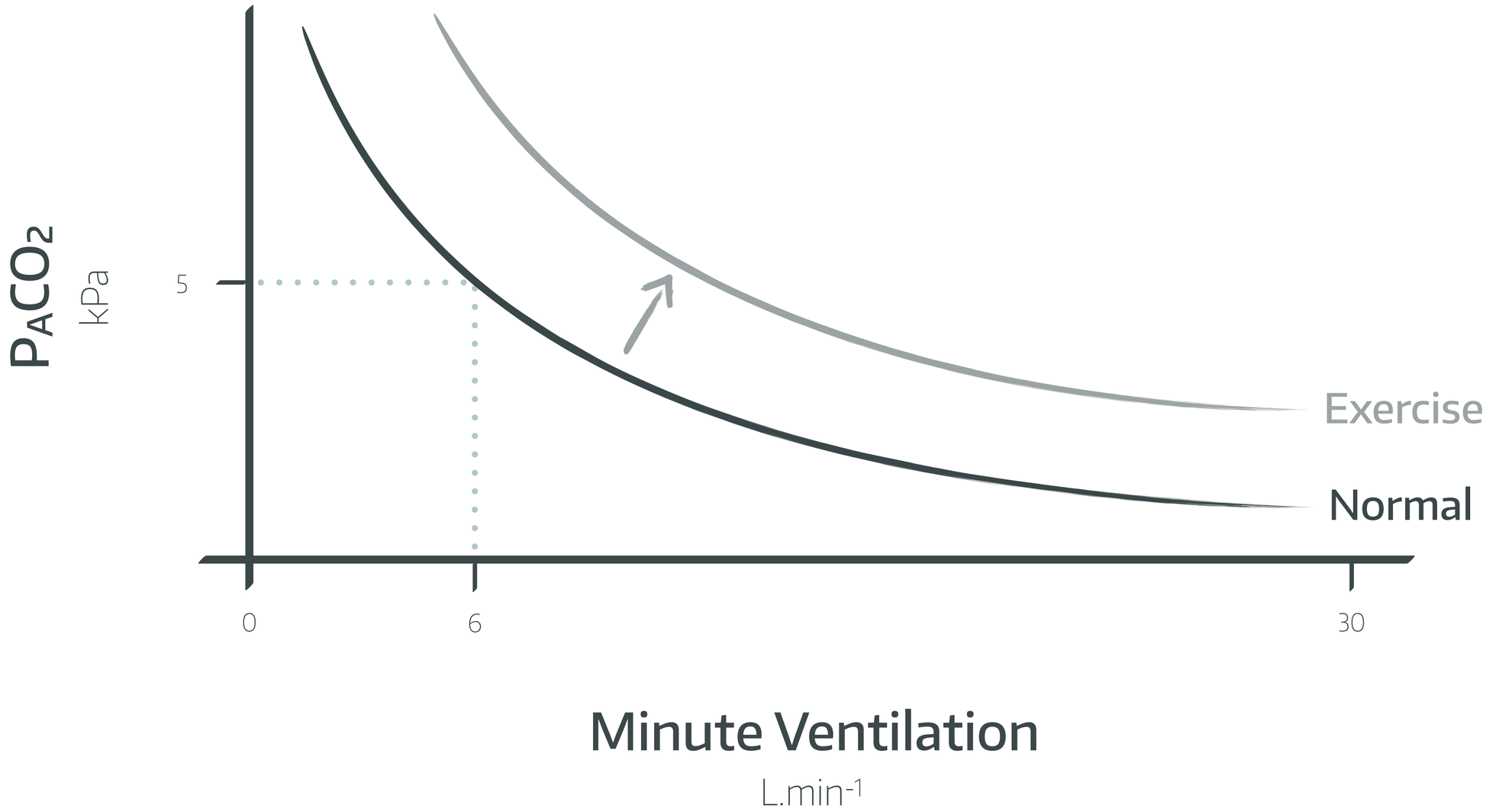
Not Pregnant

Respiratory Function

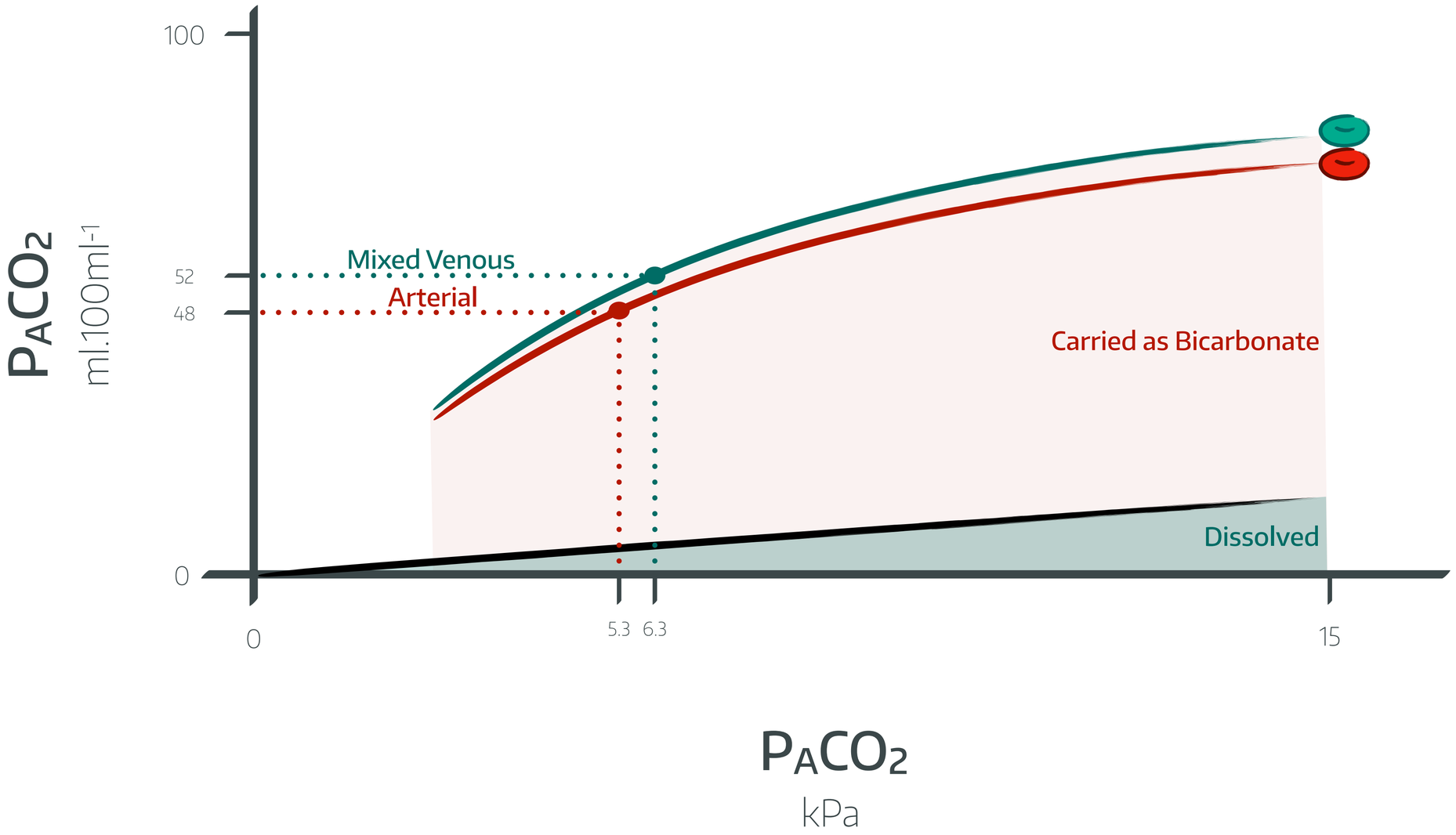
Effect of Minute Ventilation on Oxygenation



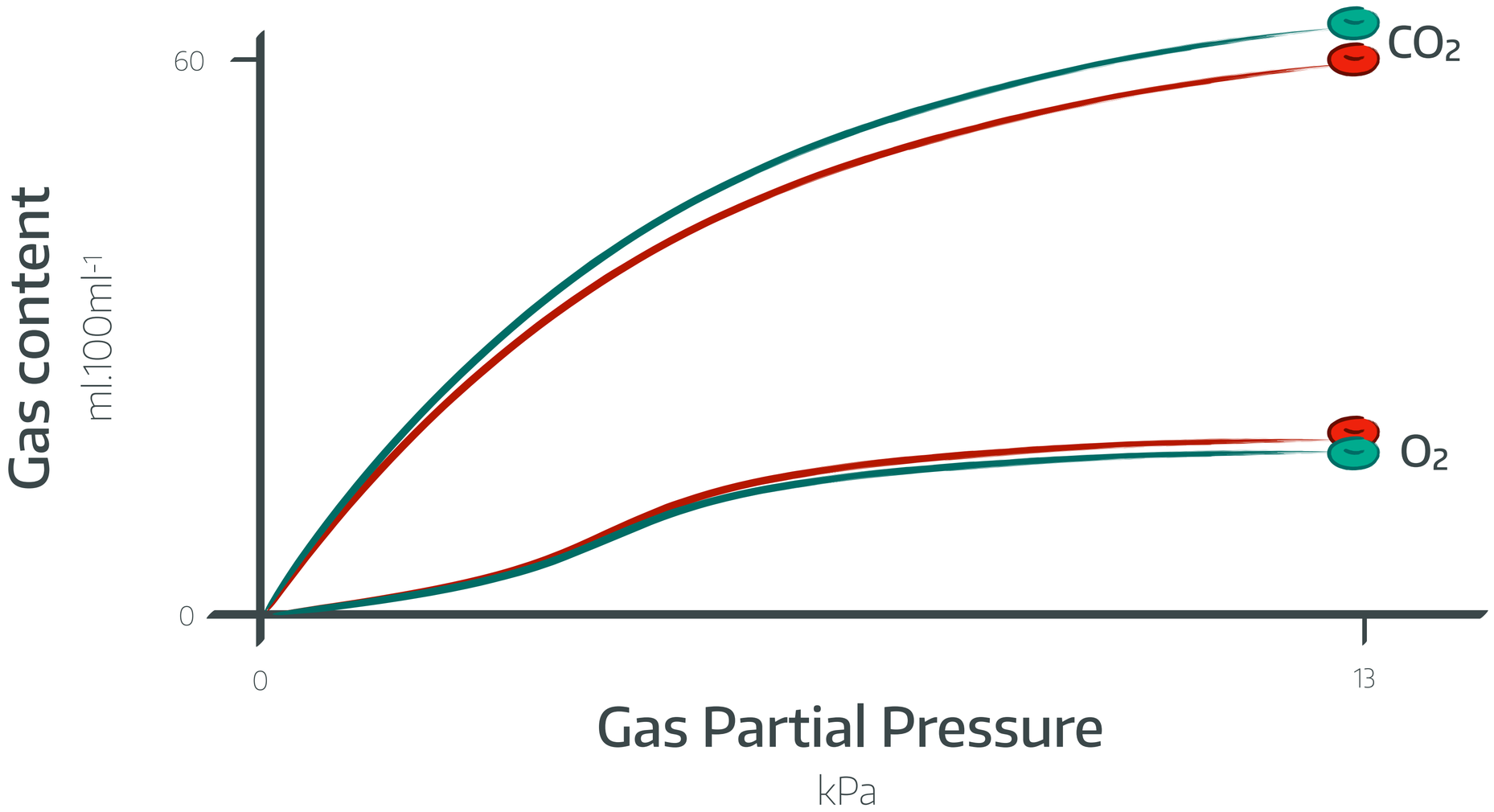
Effect of Minute Ventilation on CO_2



Transport of CO_2

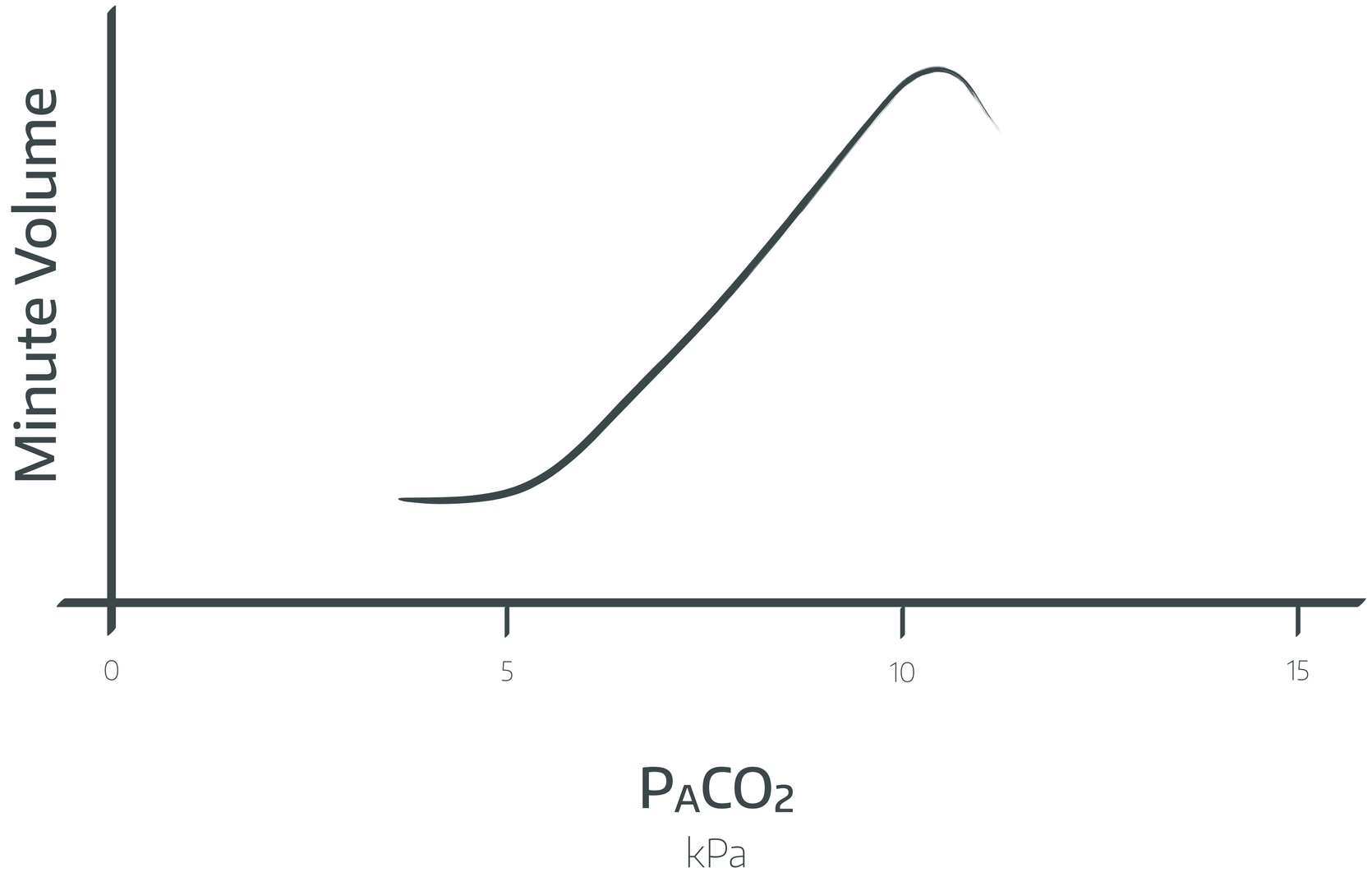


Transport of Gases

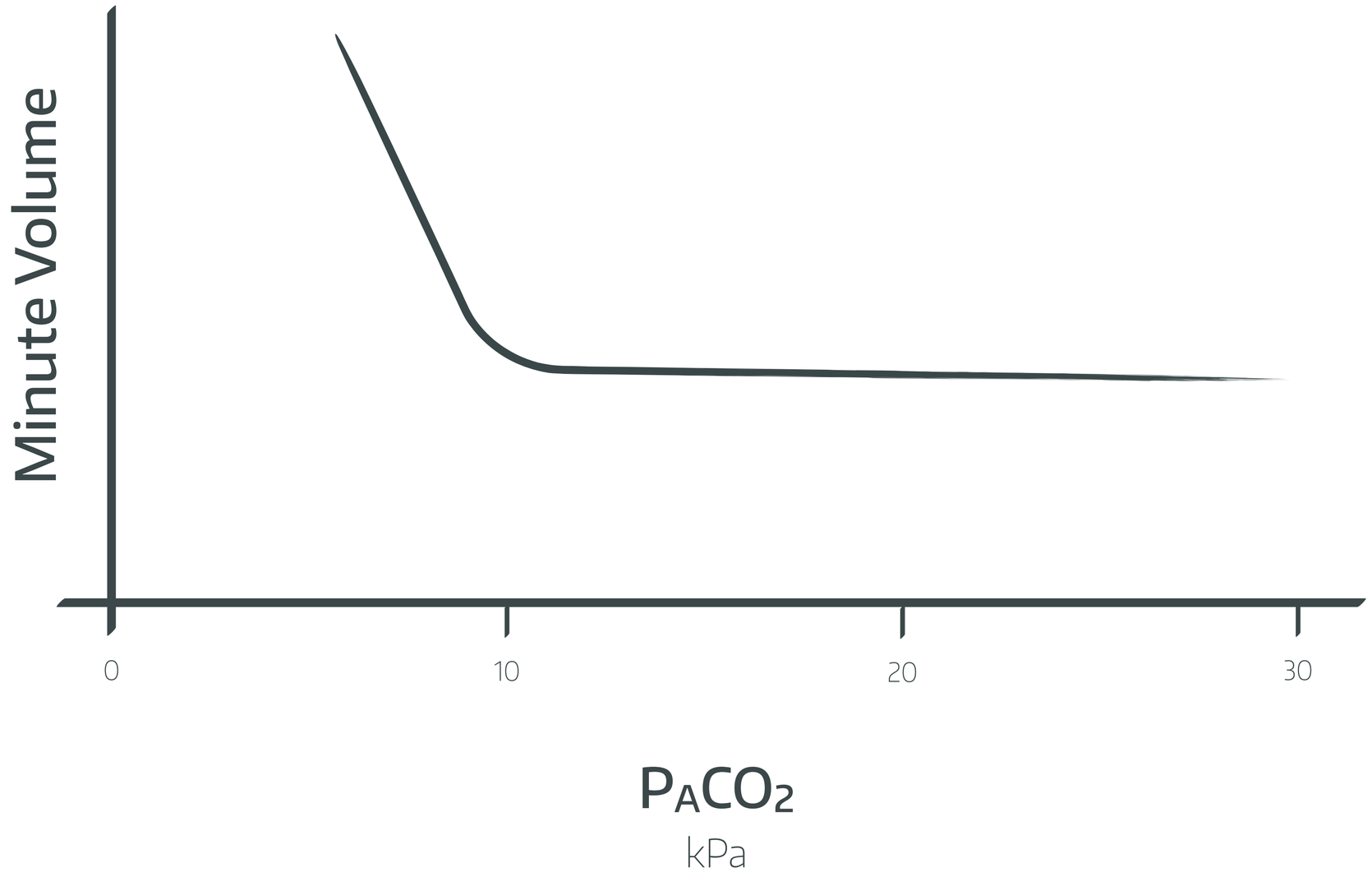


Respiratory Function

Ventilatory Response to Carbon Dioxide

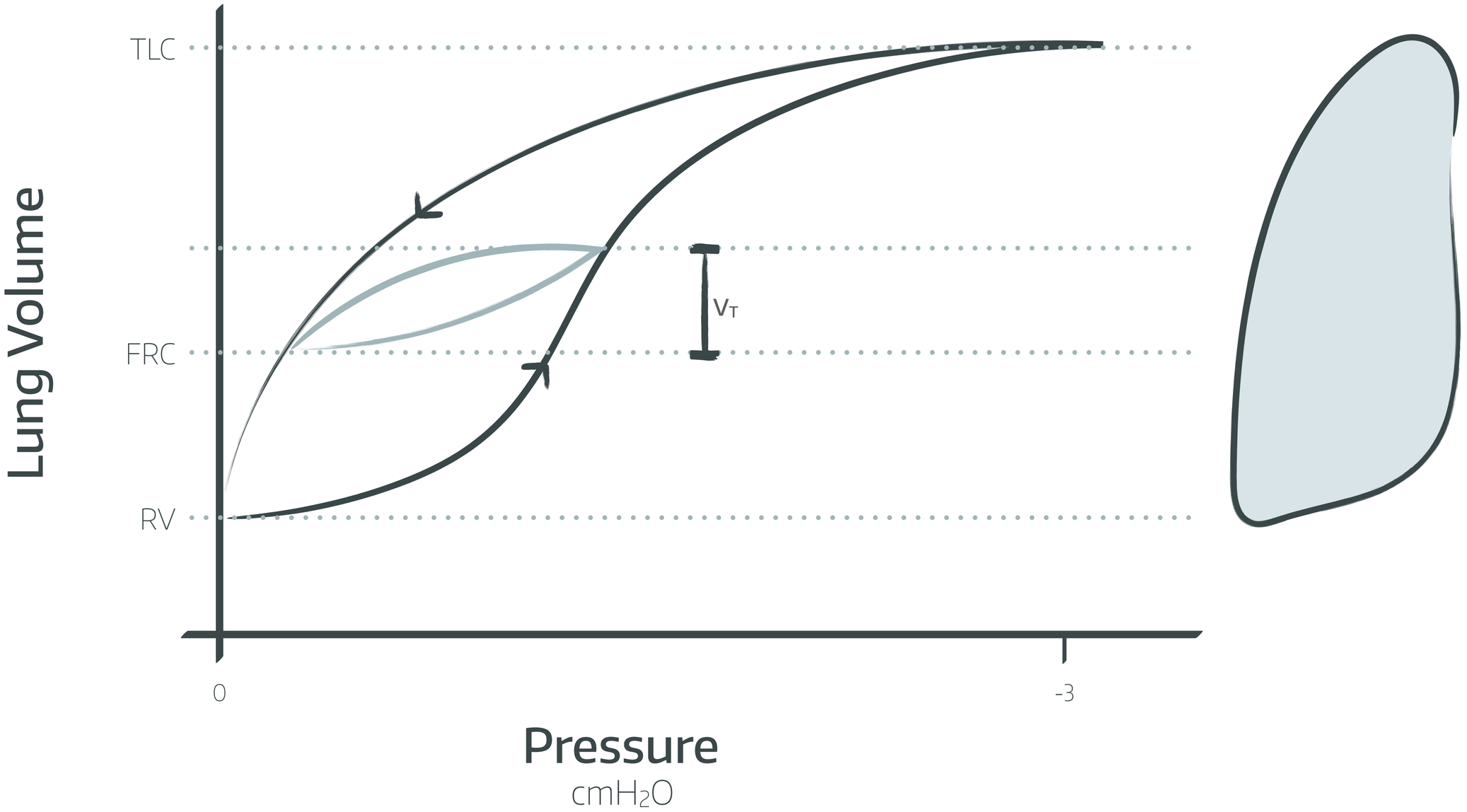


Ventilatory Response to Oxygen



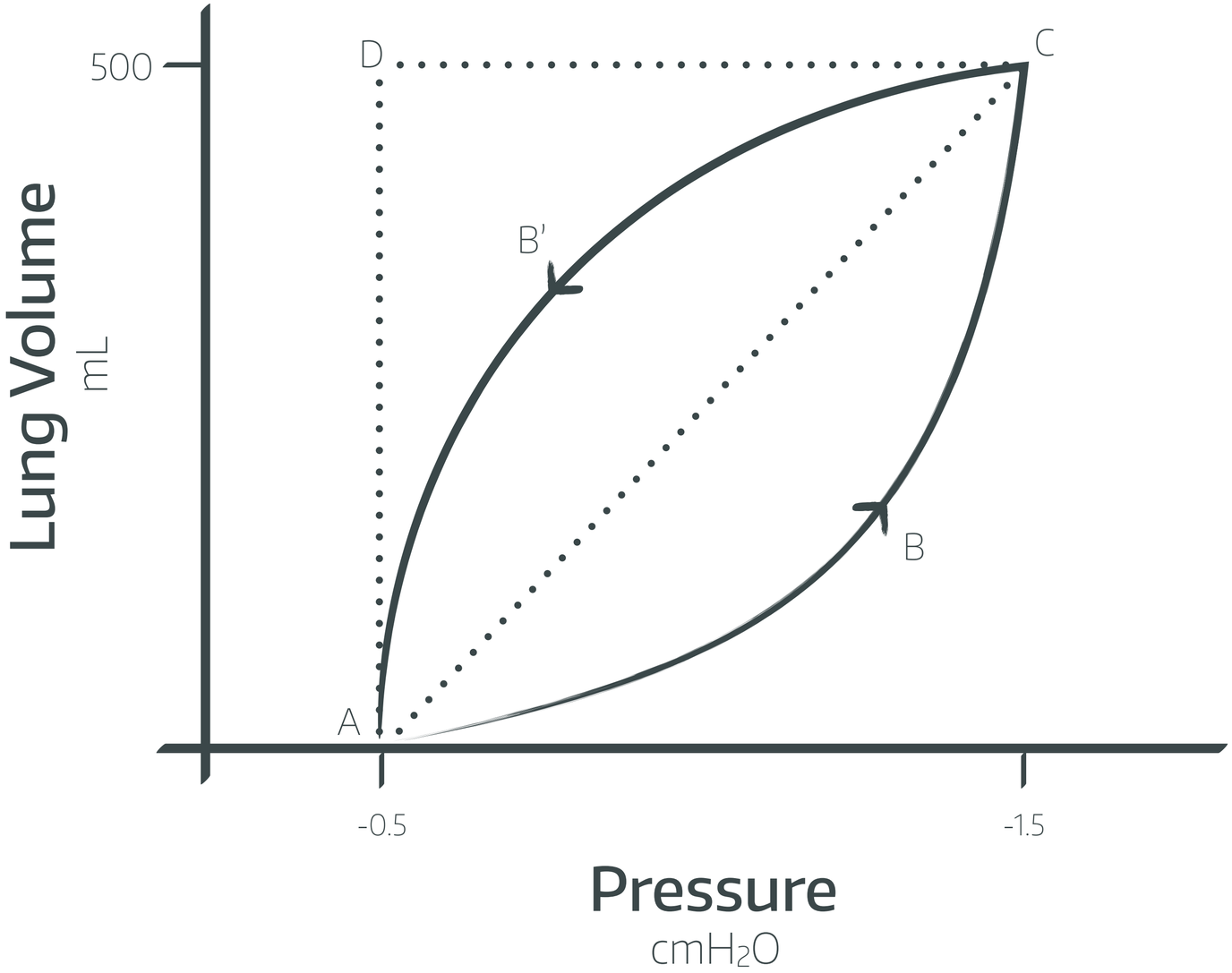
Respiratory Function

Pressure-Volume Curve



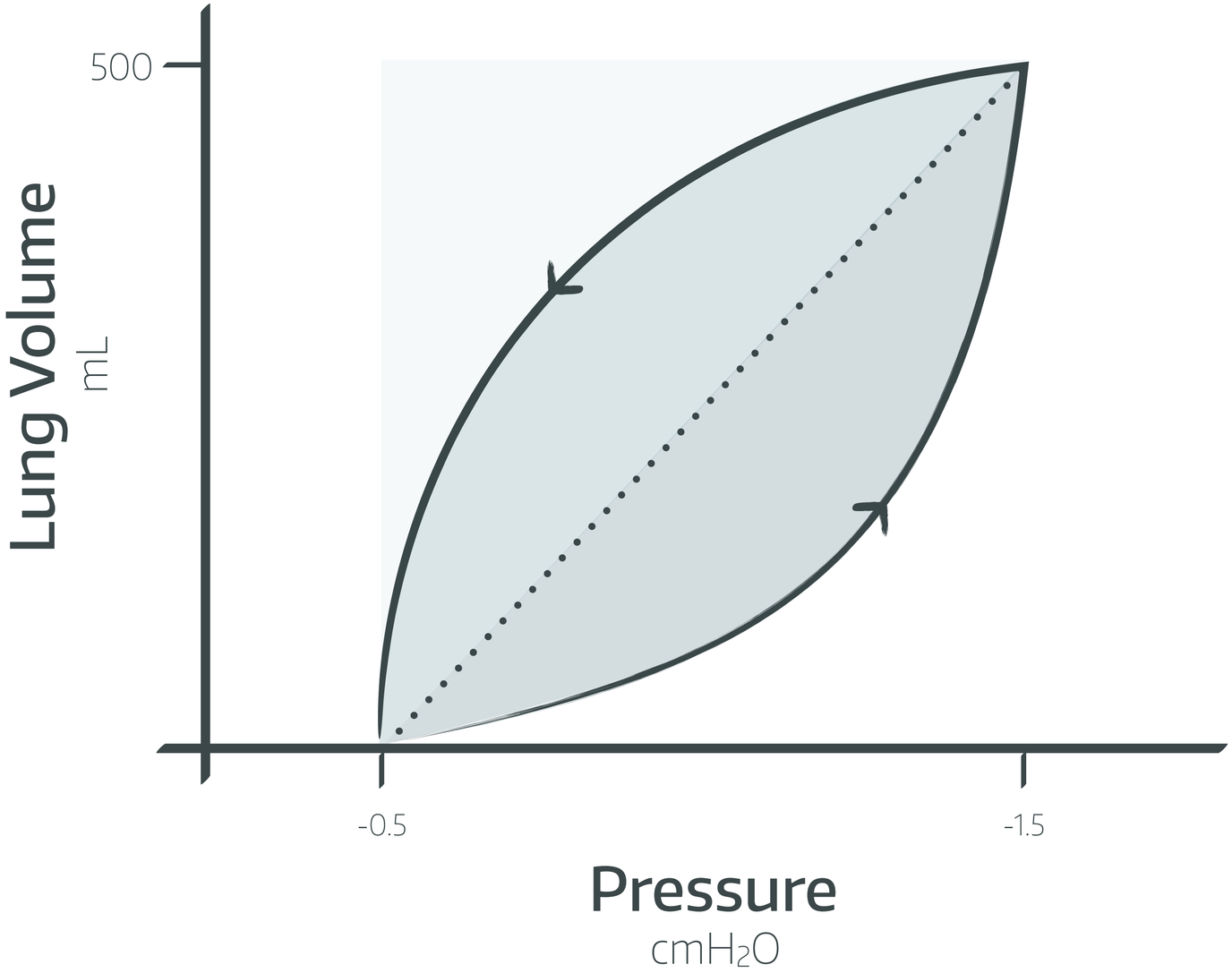
Respiratory Function

Pressure-Volume Curve

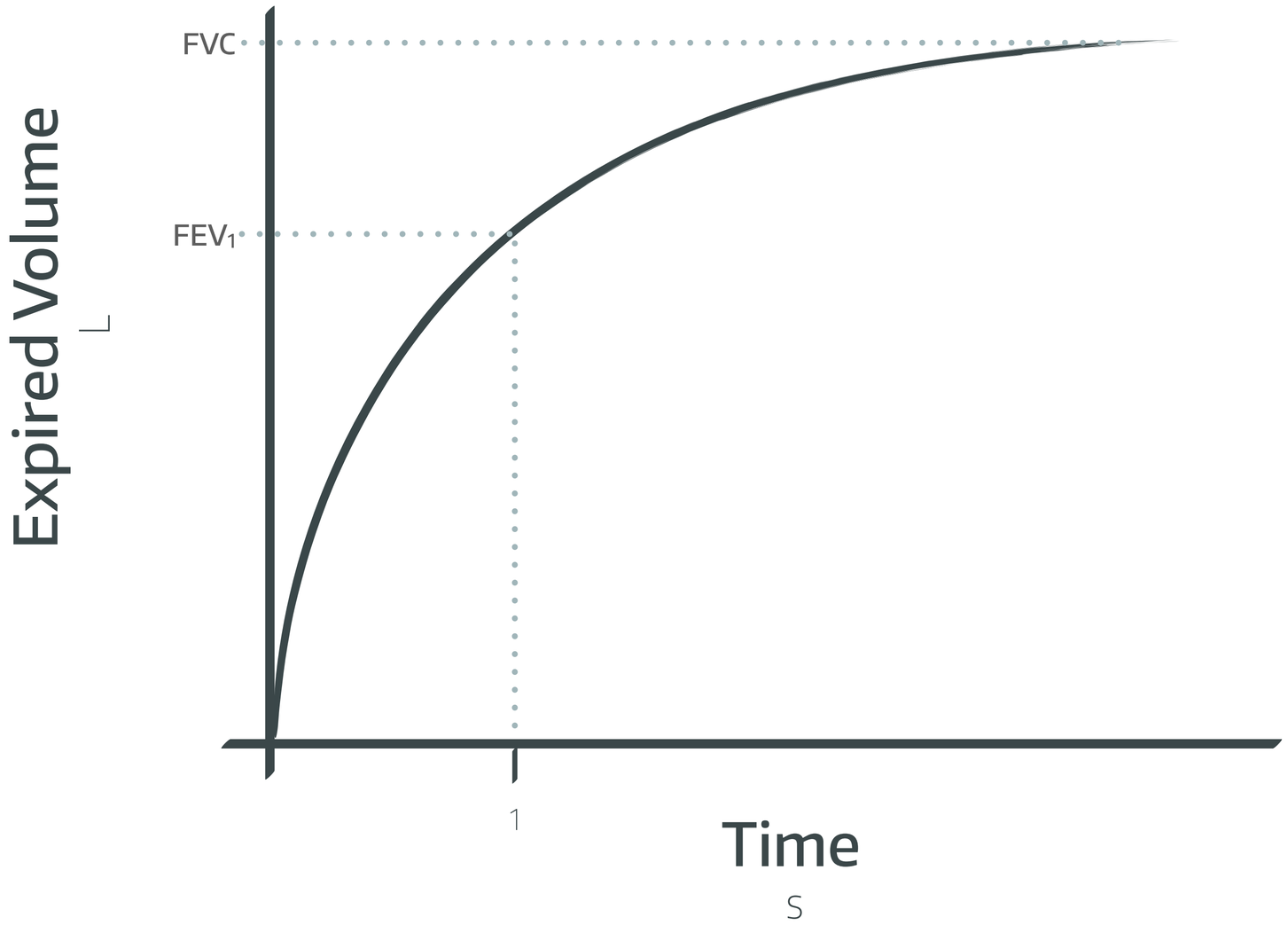


Respiratory Function

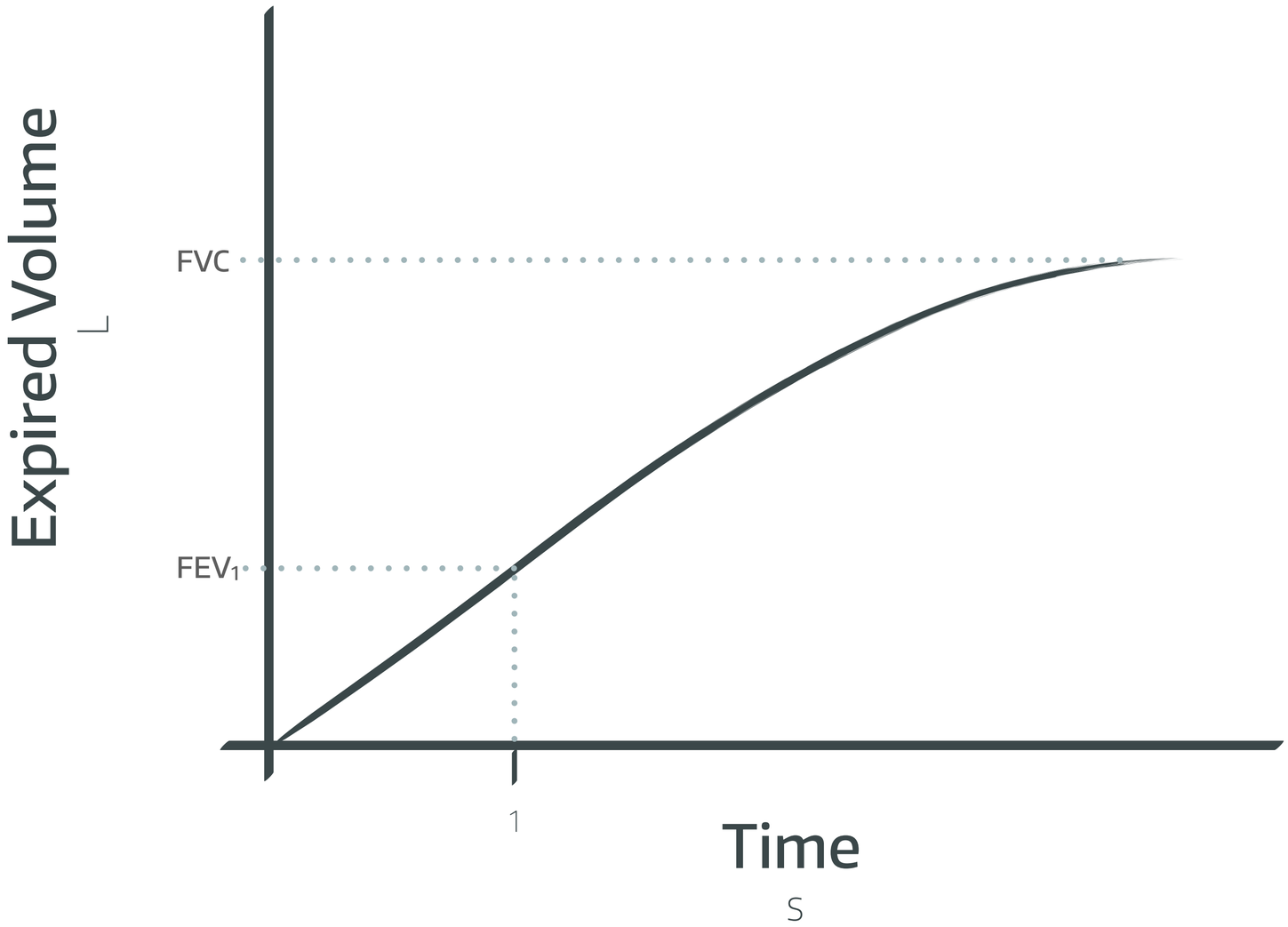
Pressure-Volume Curve



VITALOGRAPH: Normal

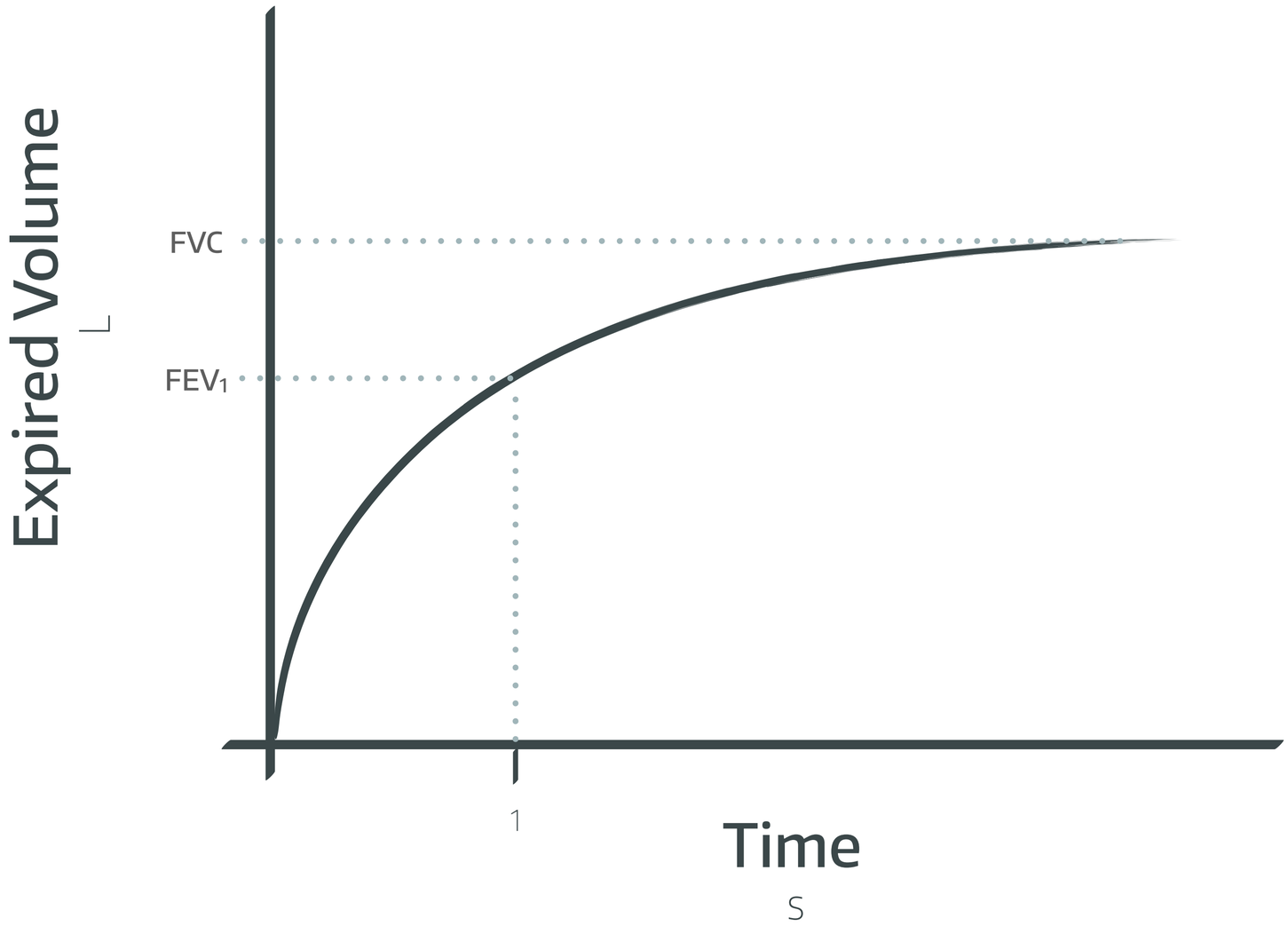


VITALOGRAPH: Obstructive

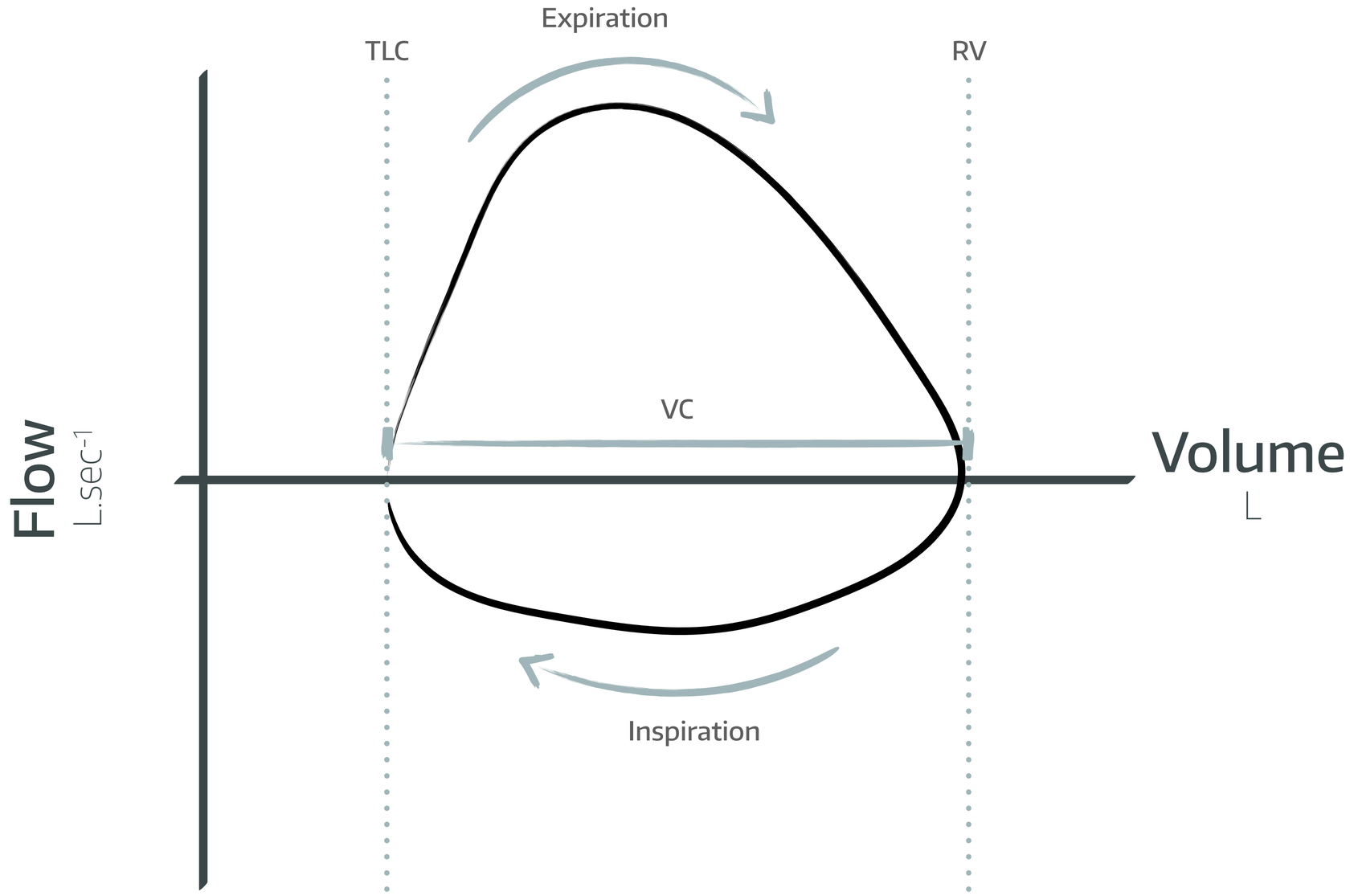


Respiratory Function

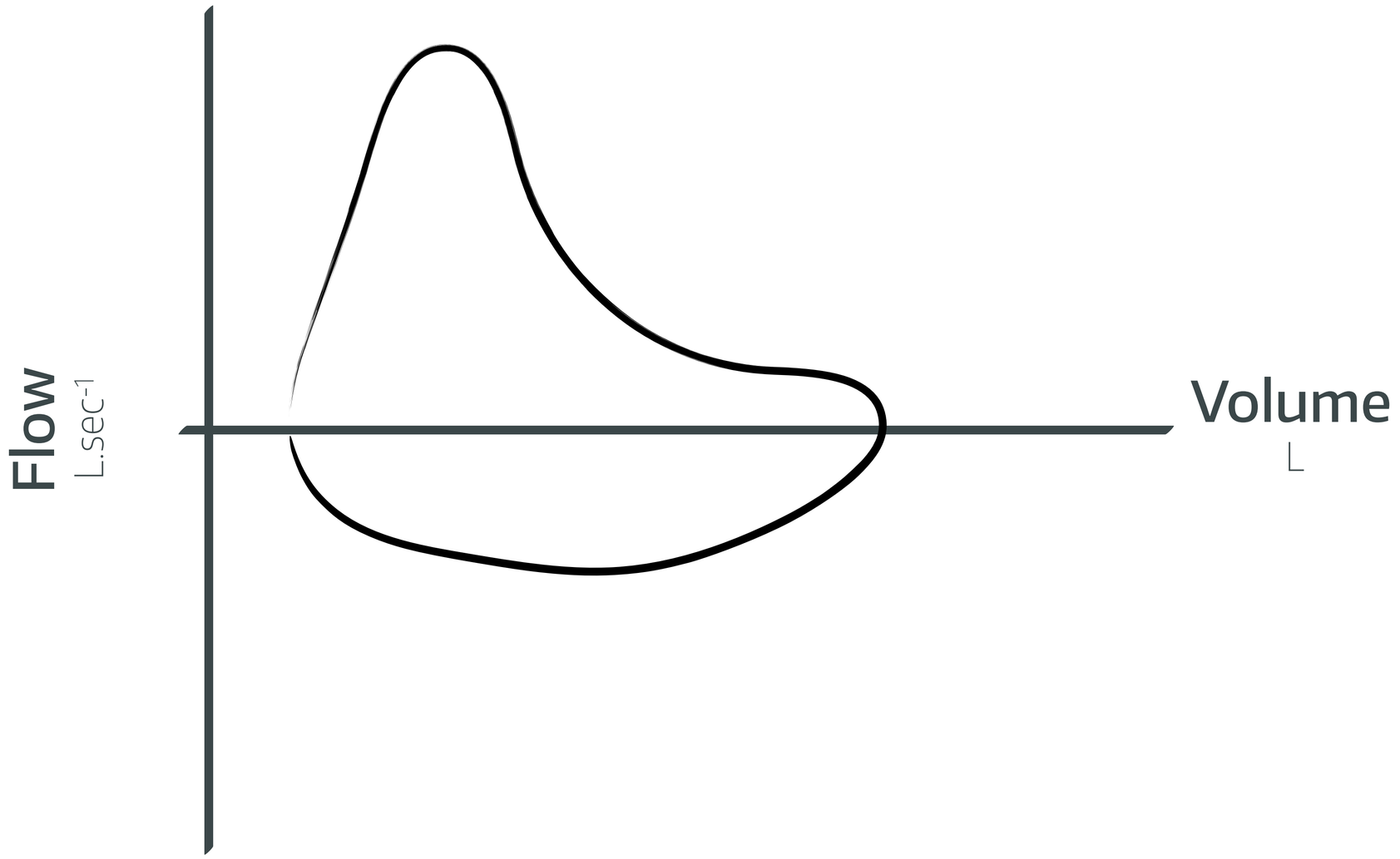
Vitalograph: Restrictive



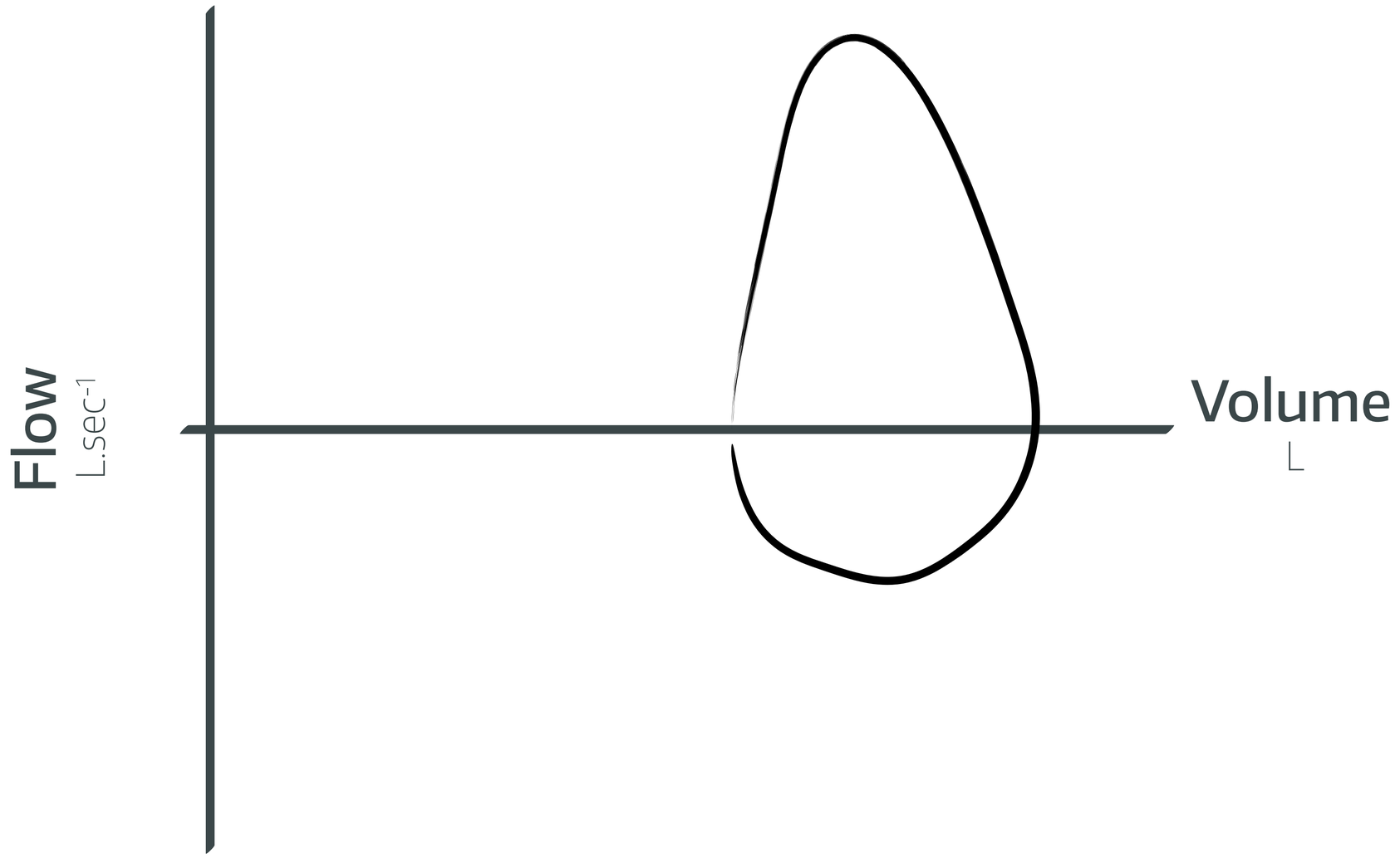
Flow-Volume Loops: Normal



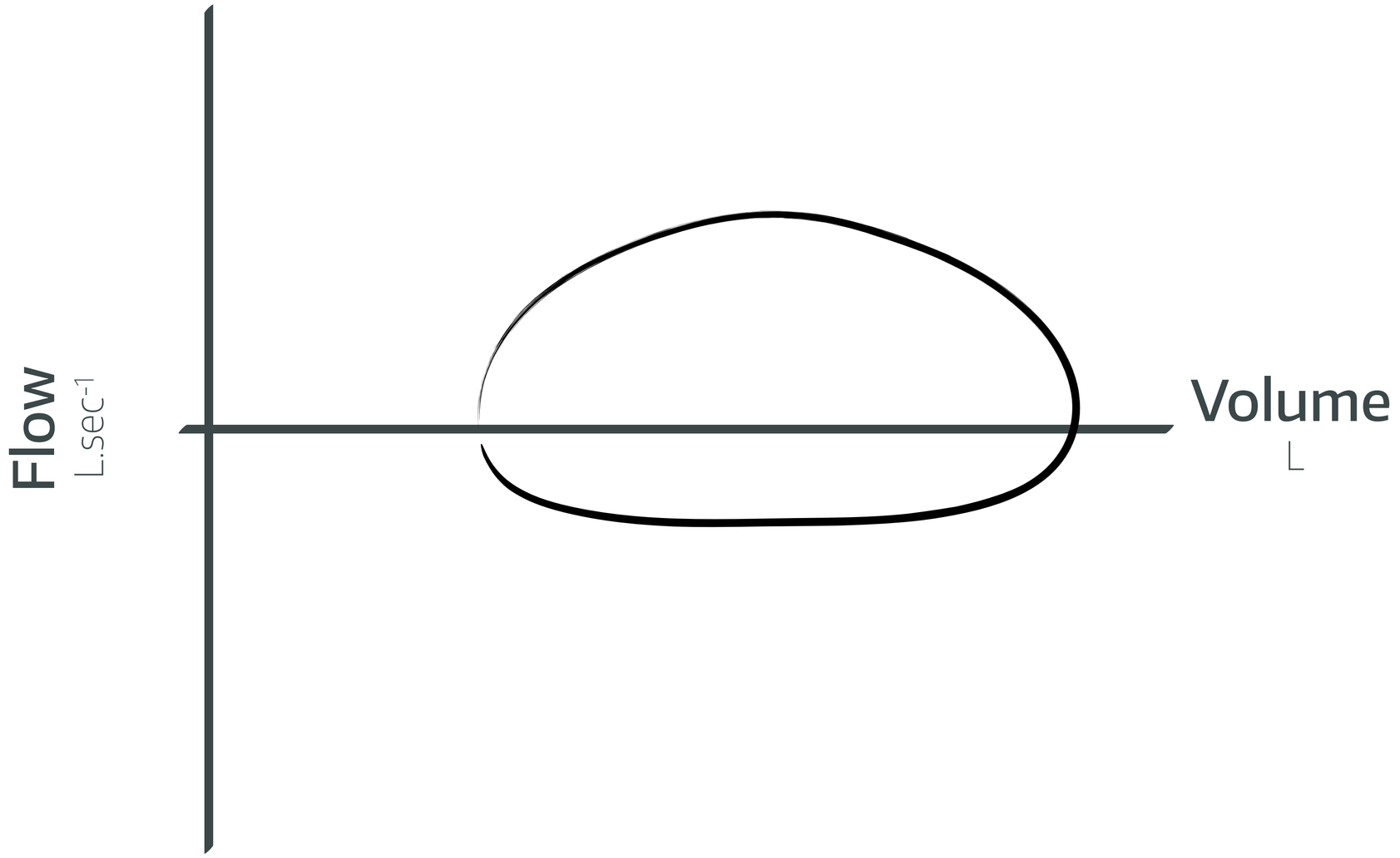
Flow-Volume Loops: Obstructive



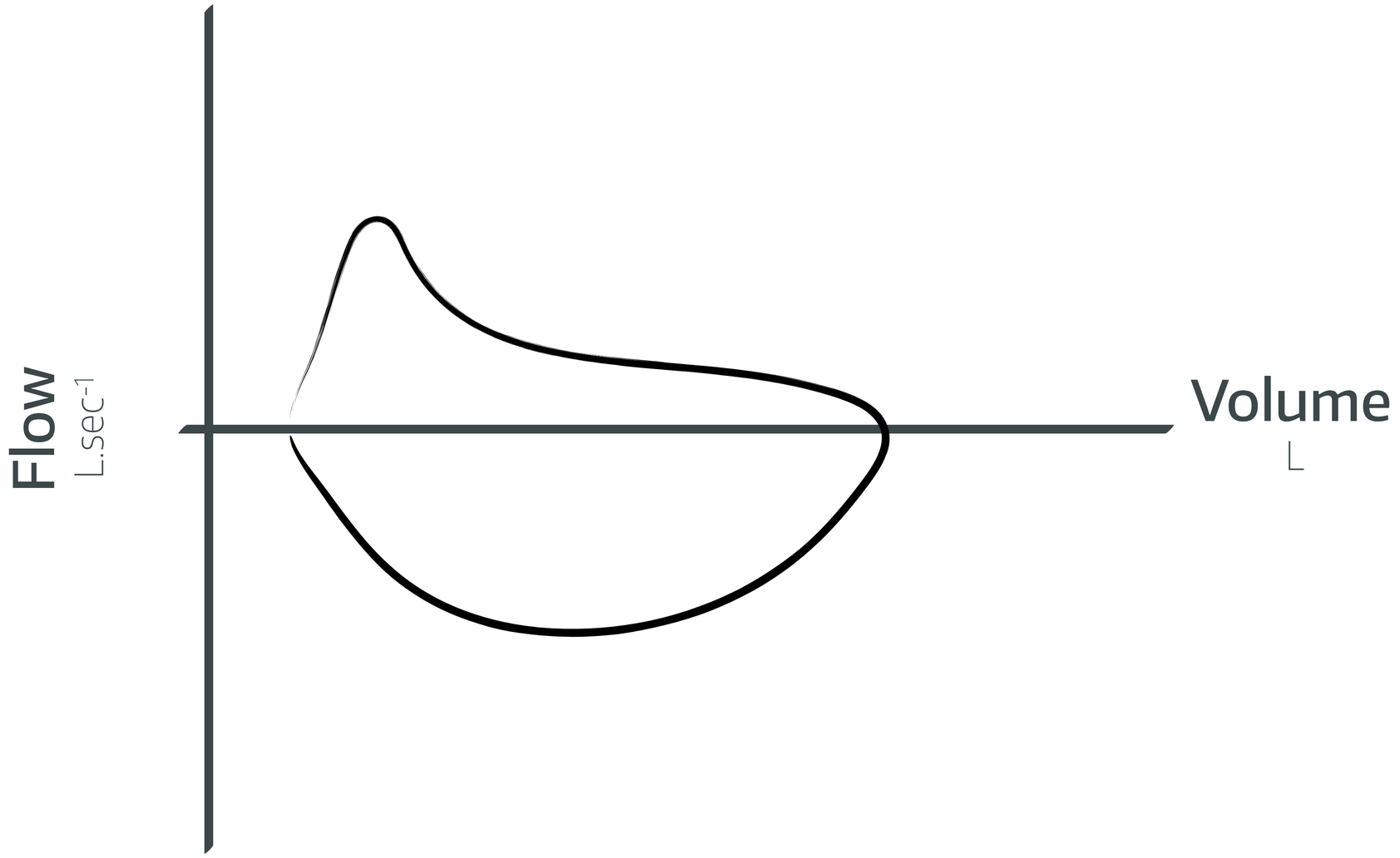
Flow-Volume Loops: Restrictive



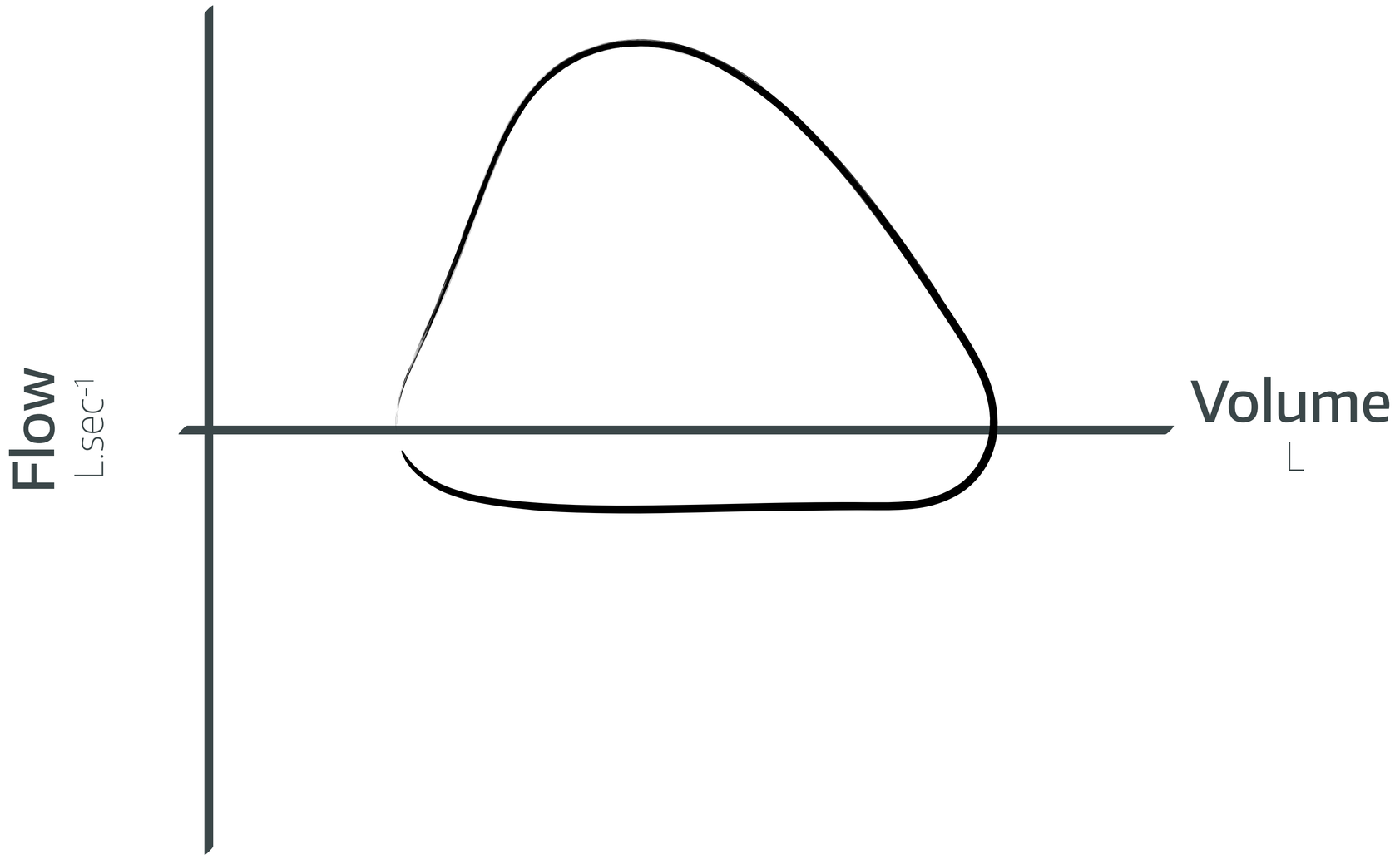
Flow-Volume Loops: Fixed Airway Obstruction



Flow-Volume Loops: Variable Intrathoracic Airway Obstruction



Flow-Volume Loops: Variable Extrathoracic Airway Obstruction



The Bohr Equation (Physiological Dead Space)

$$\frac{V_D}{V_T} = \frac{F_ACO_2 - F_ECO_2}{F_ACO_2}$$

- V_D: Dead Space
- V_T: Tidal Volume
- F_ACO_2: Fraction of Alveolar CO_2
- F_ECO_2: Fraction of Expired CO_2
- F_ACO_2: Fraction of Alveolar CO_2

The Bohr Equation (Physiological Dead Space)

Tidal Volume = Dead space + Alveolar Volume

i.e. $V_T = V_D + V_A$

$\therefore$ $V_A = V_T - V_D$ (1)

Expired CO_2 can only come from alveolar volume (not dead space)

$\therefore$ $V_T \times F_ECO_2 = V_A \times F_ACO_2$ (2)

Substitute Equation 1 into Equation 2

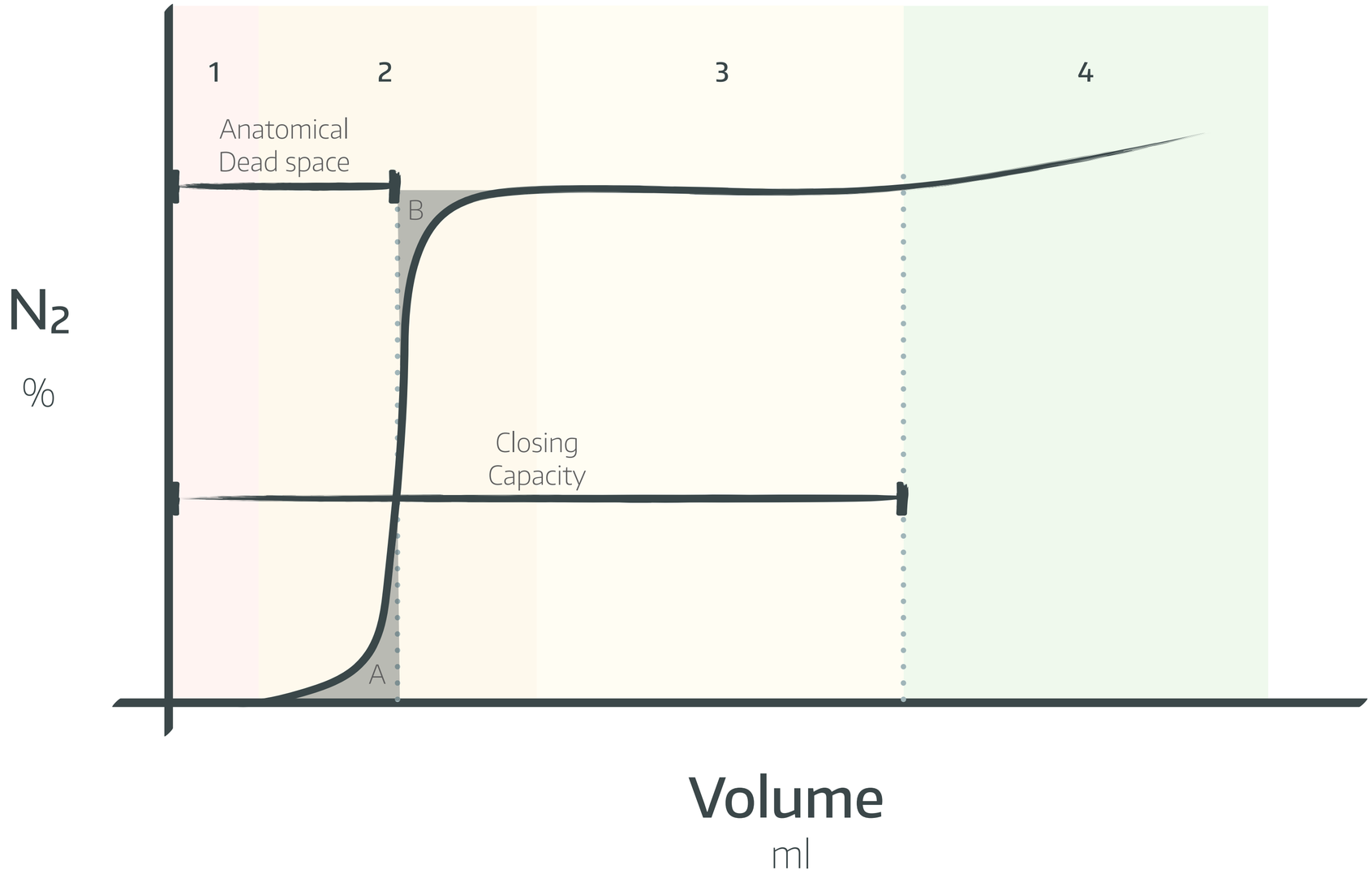
$$V_T \times F_ECO_2 = (V_T - V_D) \times F_ACO_2$$

$$V_T \times F_ECO_2 = (V_T \times F_ACO_2) - (V_D \times F_ACO_2)$$

$$V_D \times F_ACO_2 = (V_T \times F_ACO_2) - (V_T \times F_ECO_2) = V_T (F_ACO_2 - F_ECO_2)$$

$$\frac{V_D}{V_T} = \frac{F_ACO_2 - F_ECO_2}{F_ACO_2}$$

Fowler's Method (Anatomical Dead Space)



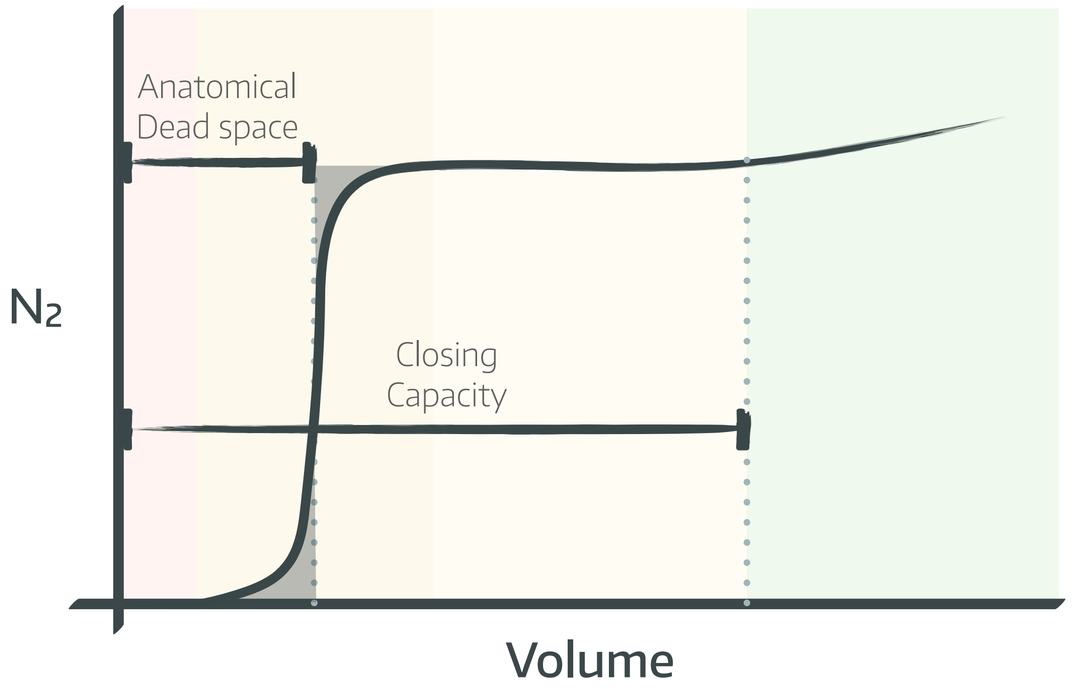
Fowler's Method (Anatomical Dead Space)

Steps

1. 100% O_2 Vital Capacity Breath
2. Exhale to Residual volume to measure N_2 content & volume
3. Plot [N_2] against Volume

Measured & Derived Parameters

Closing Volume
Closing Capacity
Closing Volume : Vital Capacity Ratio
Closing Capacity : Total Lung Capacity Ratio



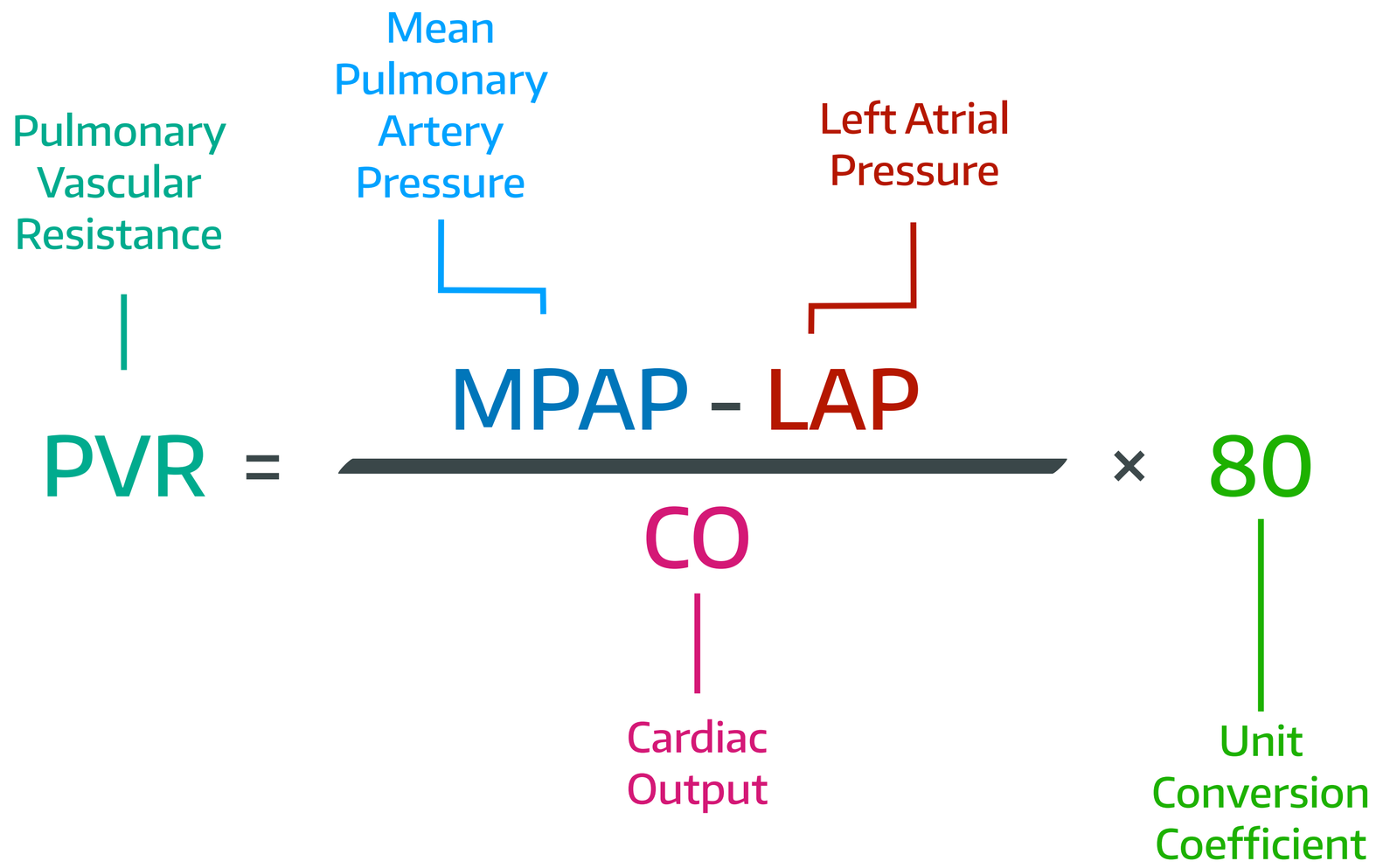
Pure Dead Space. 100% O_2 as there is no gas exchange here

Pure Alveolar Gas. Plateau phase.

Mixture of O_2 & N_2 from alveolar units

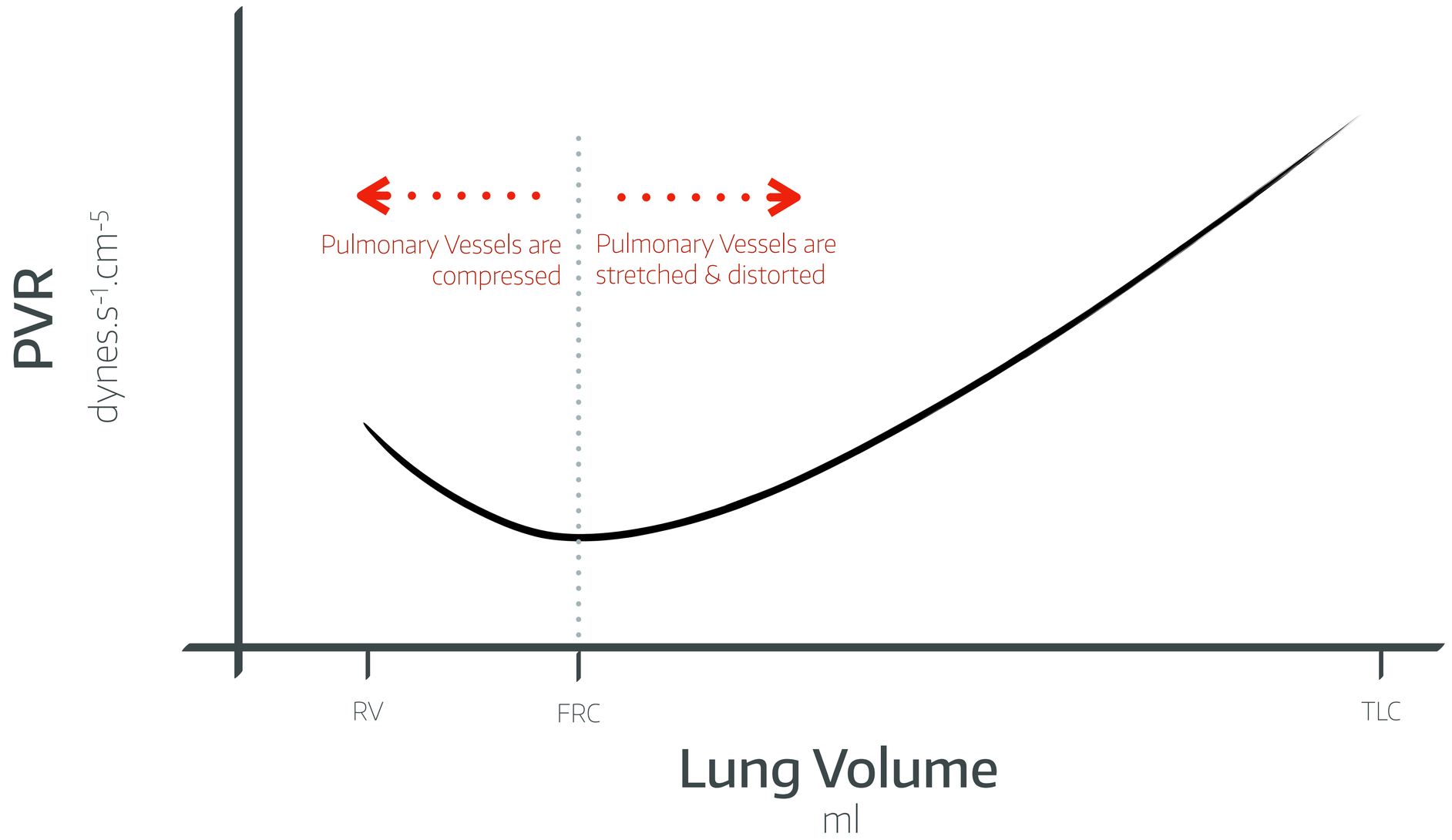
Closing Capacity corresponds to sudden N_2 increase

Pulmonary Vascular Resistance

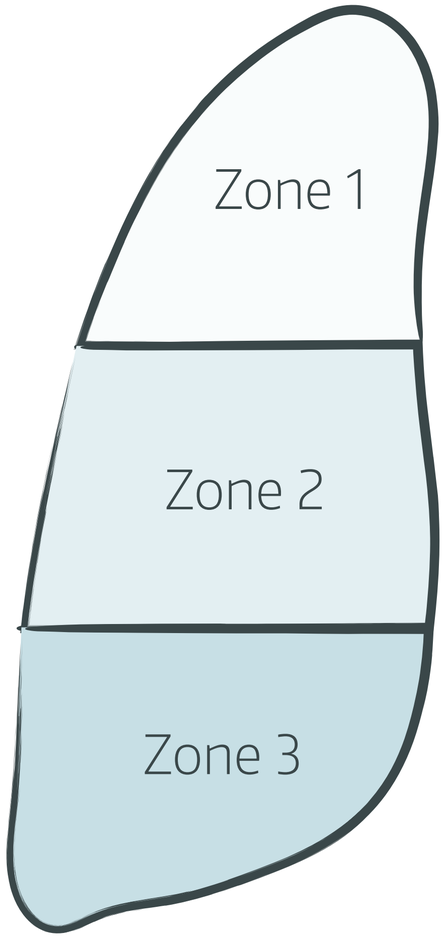


Respiratory Function

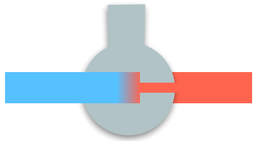
Pulmonary Vascular Resistance



West Zones

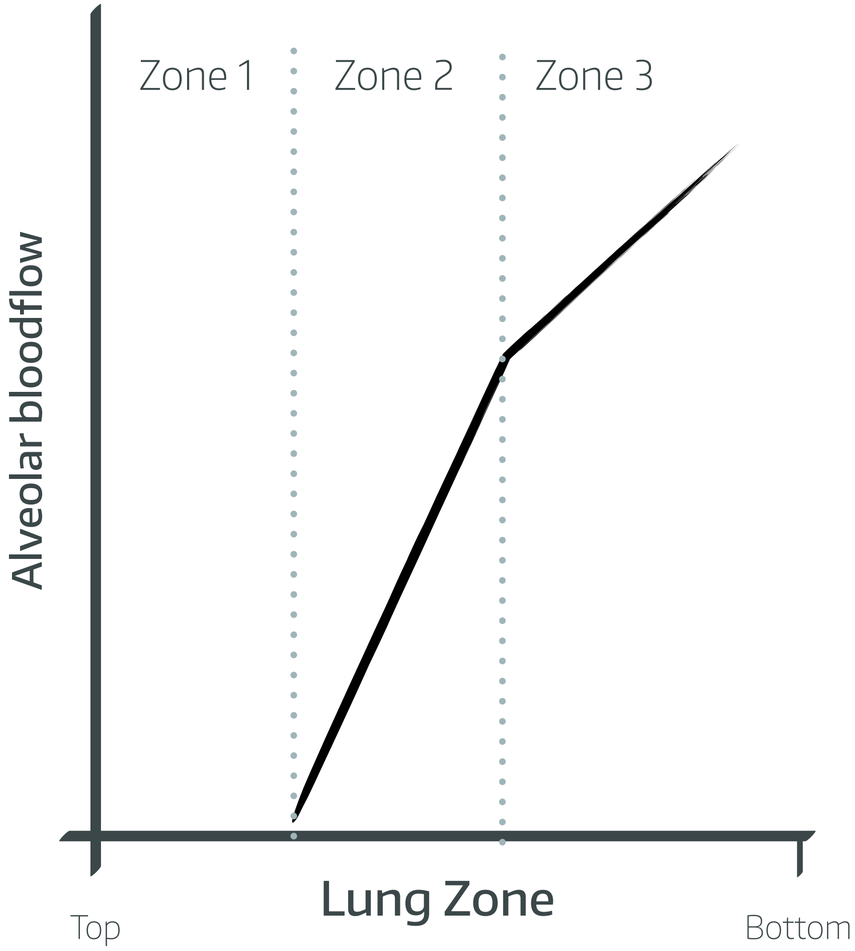


$P_A > P_a > P_v$



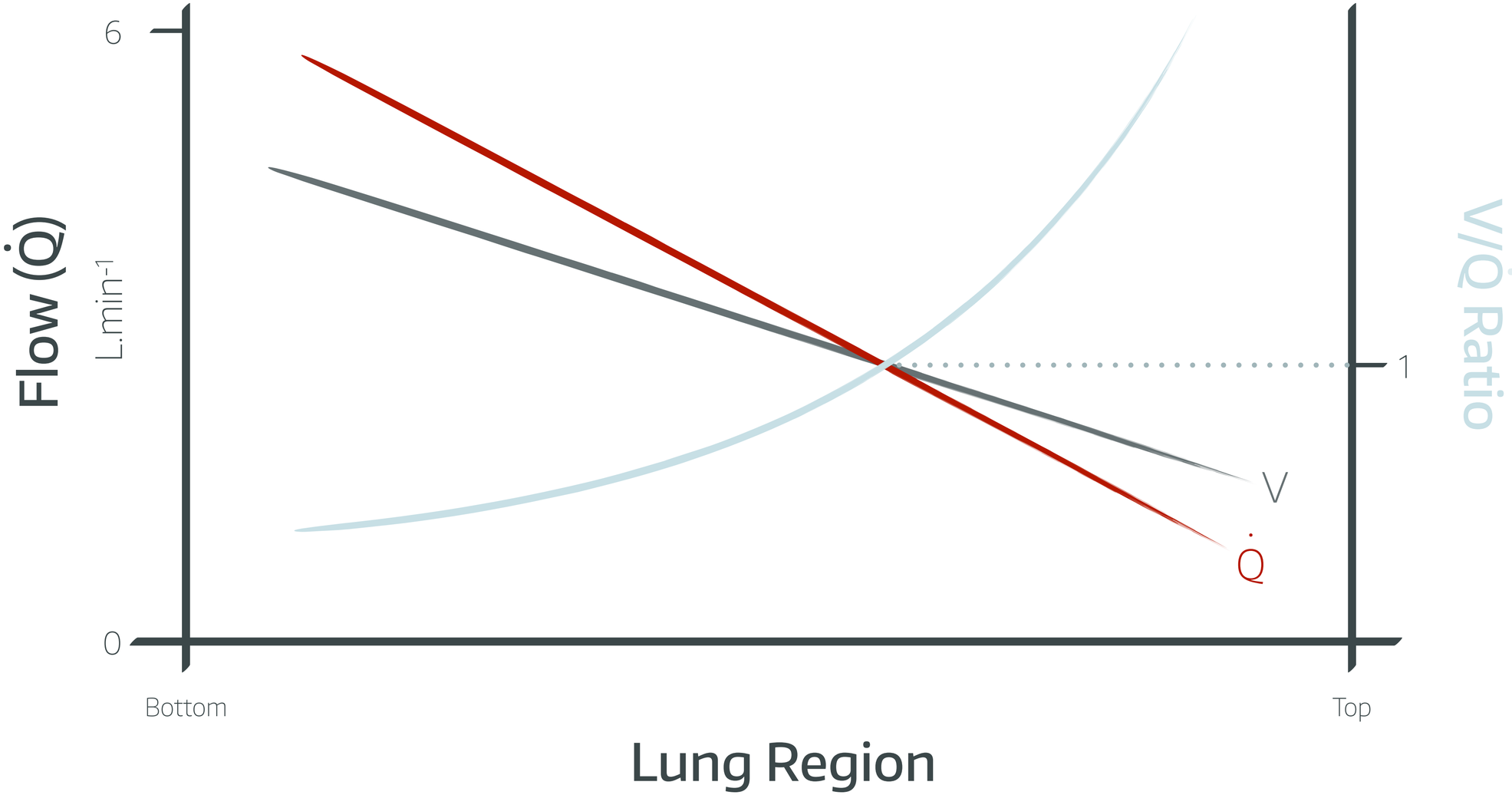
$P_a > P_A > P_v$

$P_a > P_v > P_A$



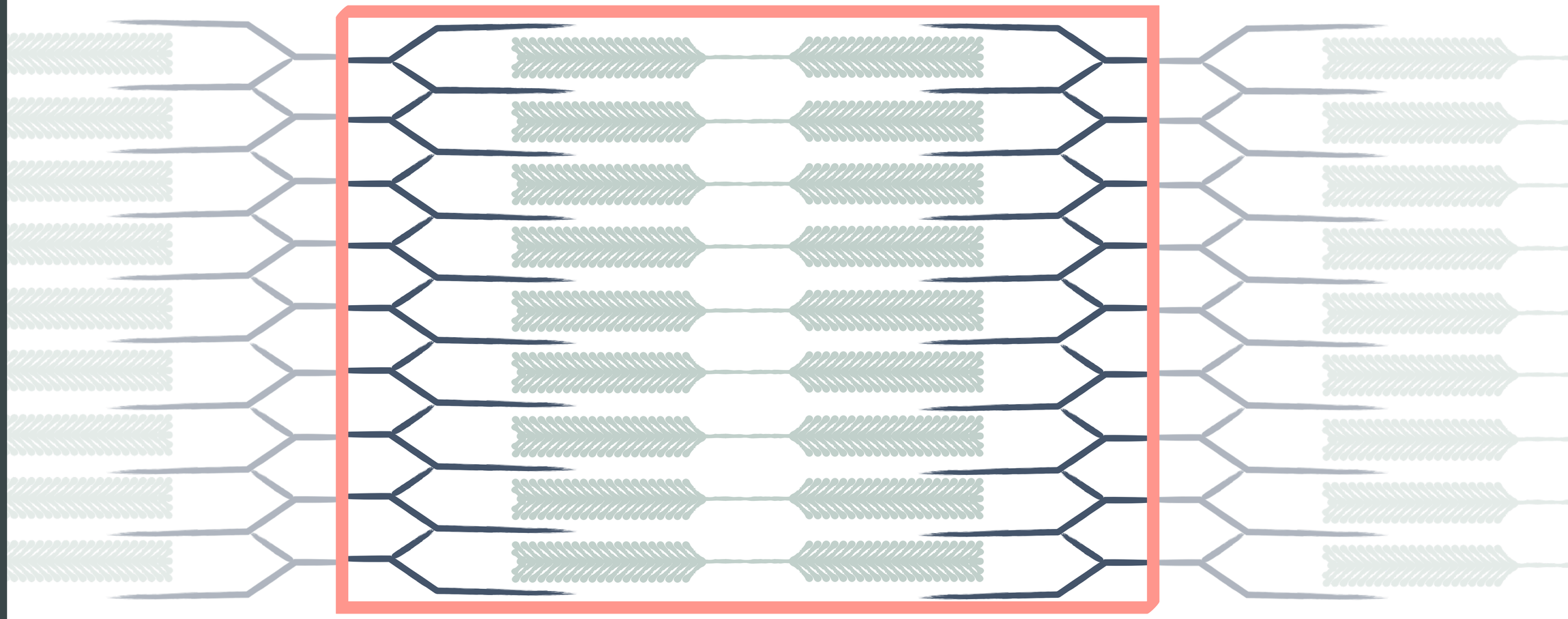
Respiratory Function

Ventilation-Perfusion Matching

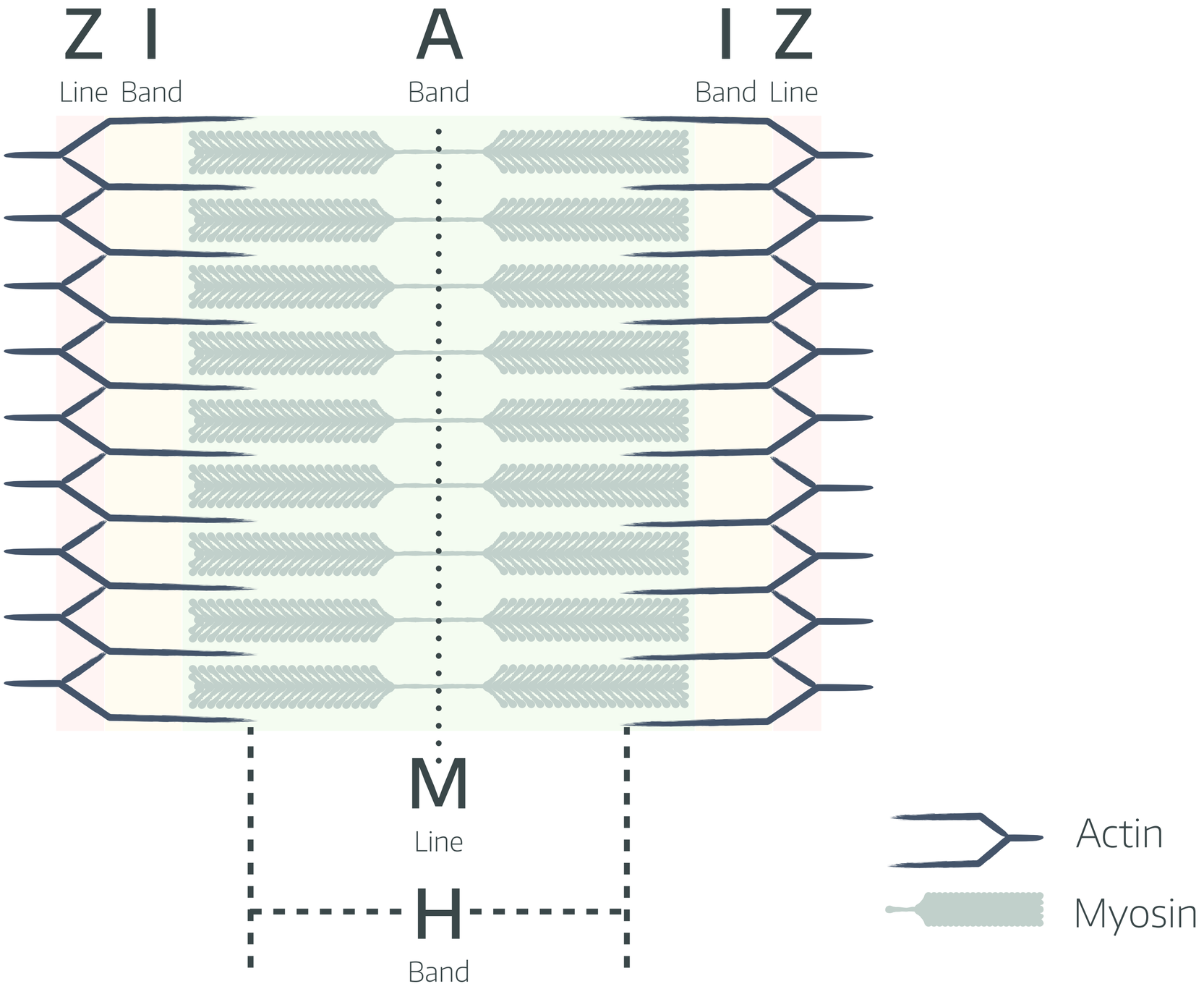


Muscle Function

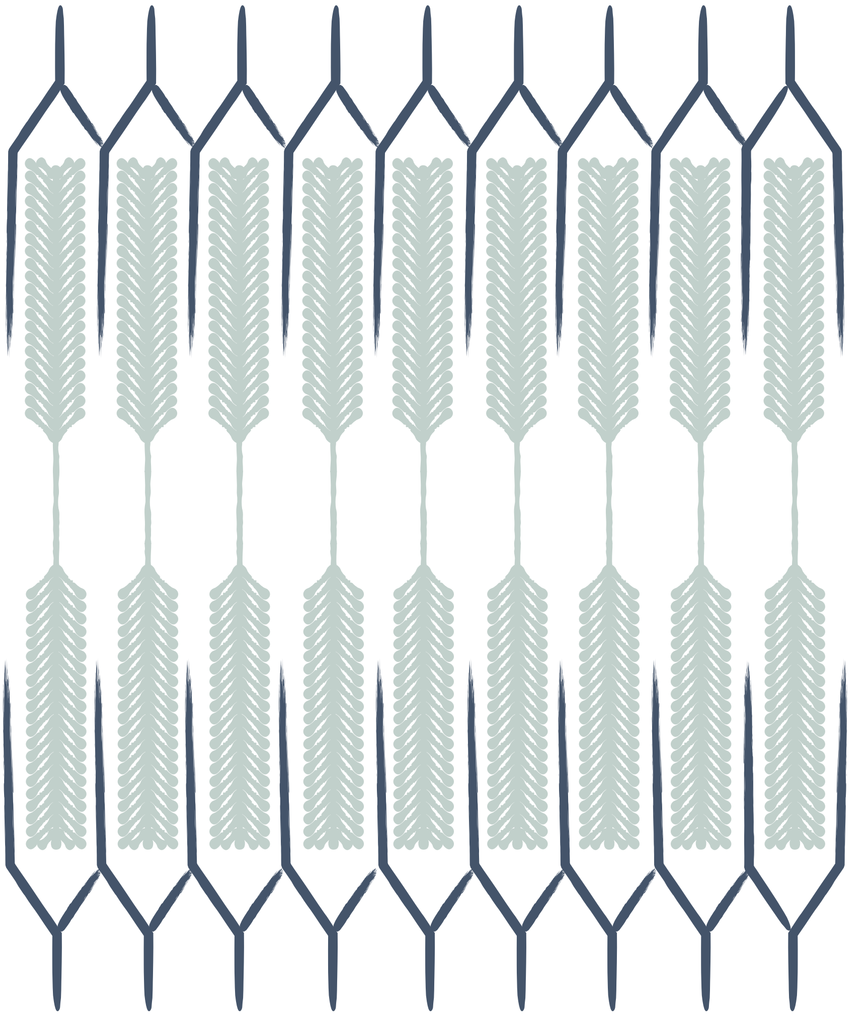
The Sarcomere



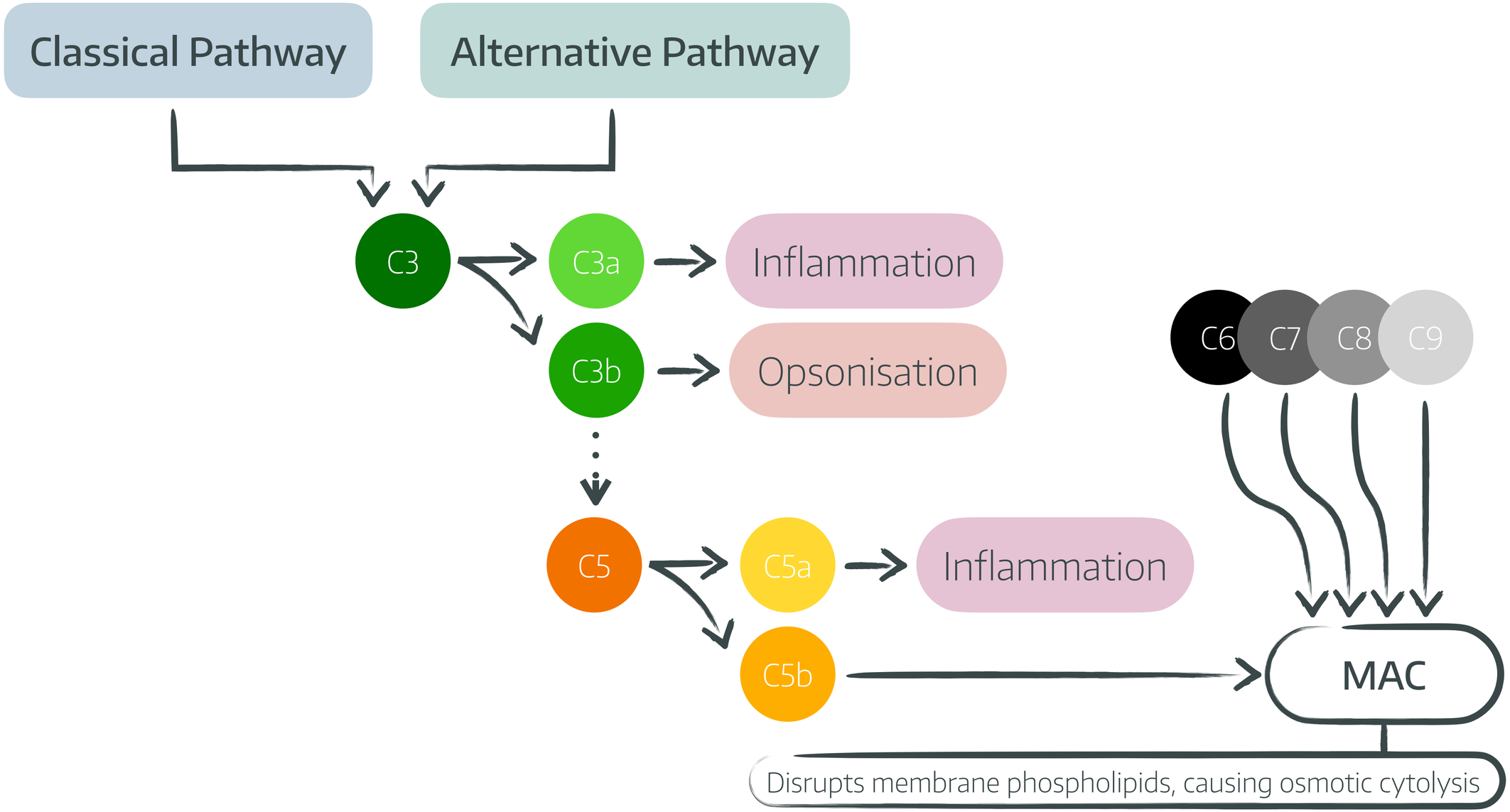
Muscle Function



Muscle Function



COMPLEMENT


Classical Pathway
Alternative Pathway
C3
C3a
Inflammation
C3b
Opsonisation
C5
C5a
Inflammation
C5b
C6
C7
C8
C9
MAC
Disrupts membrane phospholipids, causing osmotic cytolysis

HAEMATOLOGY

Omnipotent Stem Cell

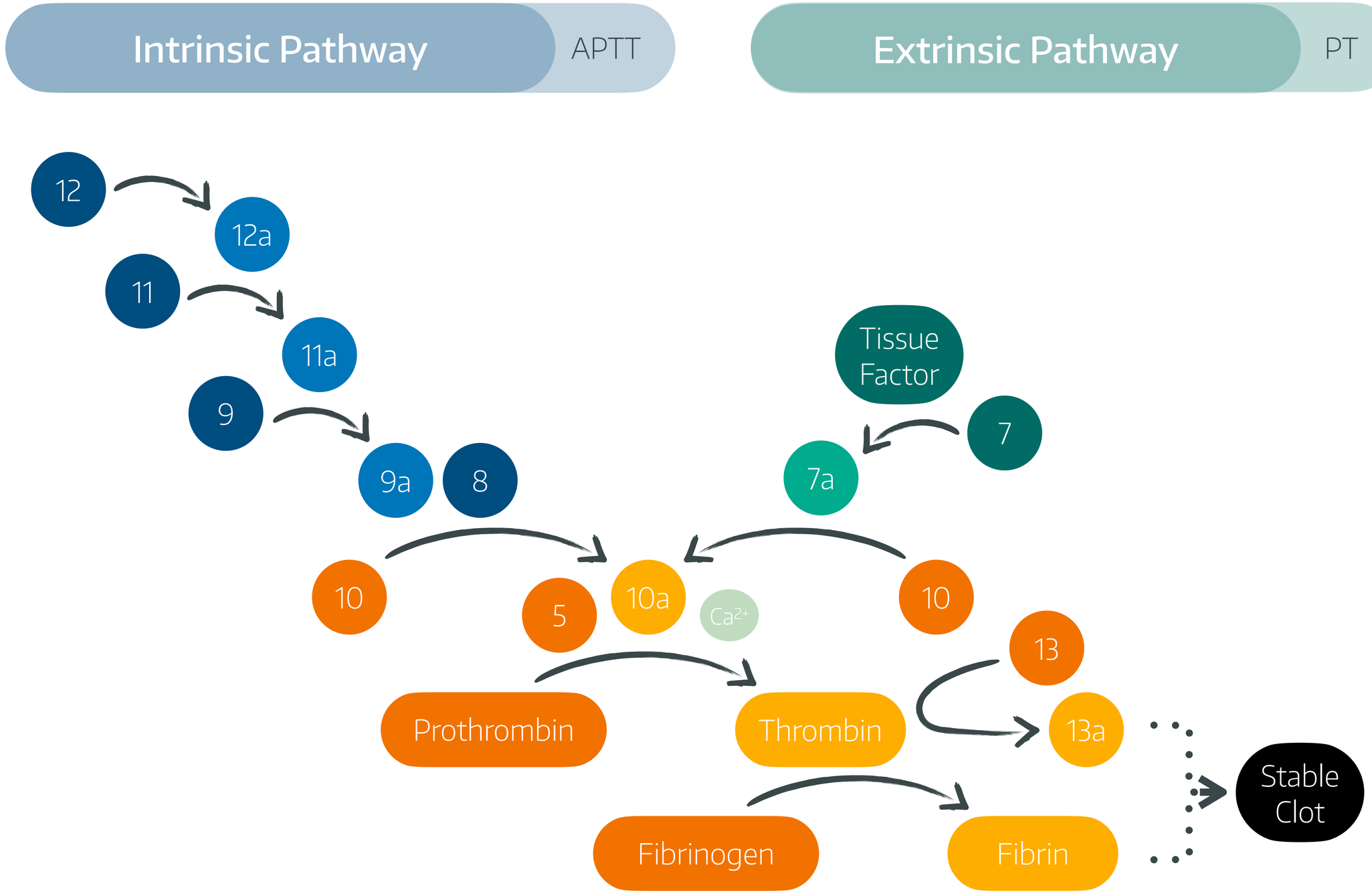
Myeloid

- **Erythrocyte**
- **Platelet**
- Myeloblast
  - Granulocyte
    - **Eosinophil**
      - Attack Helminths & Parasites
    - Basophil
      - **Mast Cell**
    - **Neutrophil**
      - Phagocytosis & Inflammatory Mediators (60% of WCC)
    - **Monocyte**
      - Phagocytosis

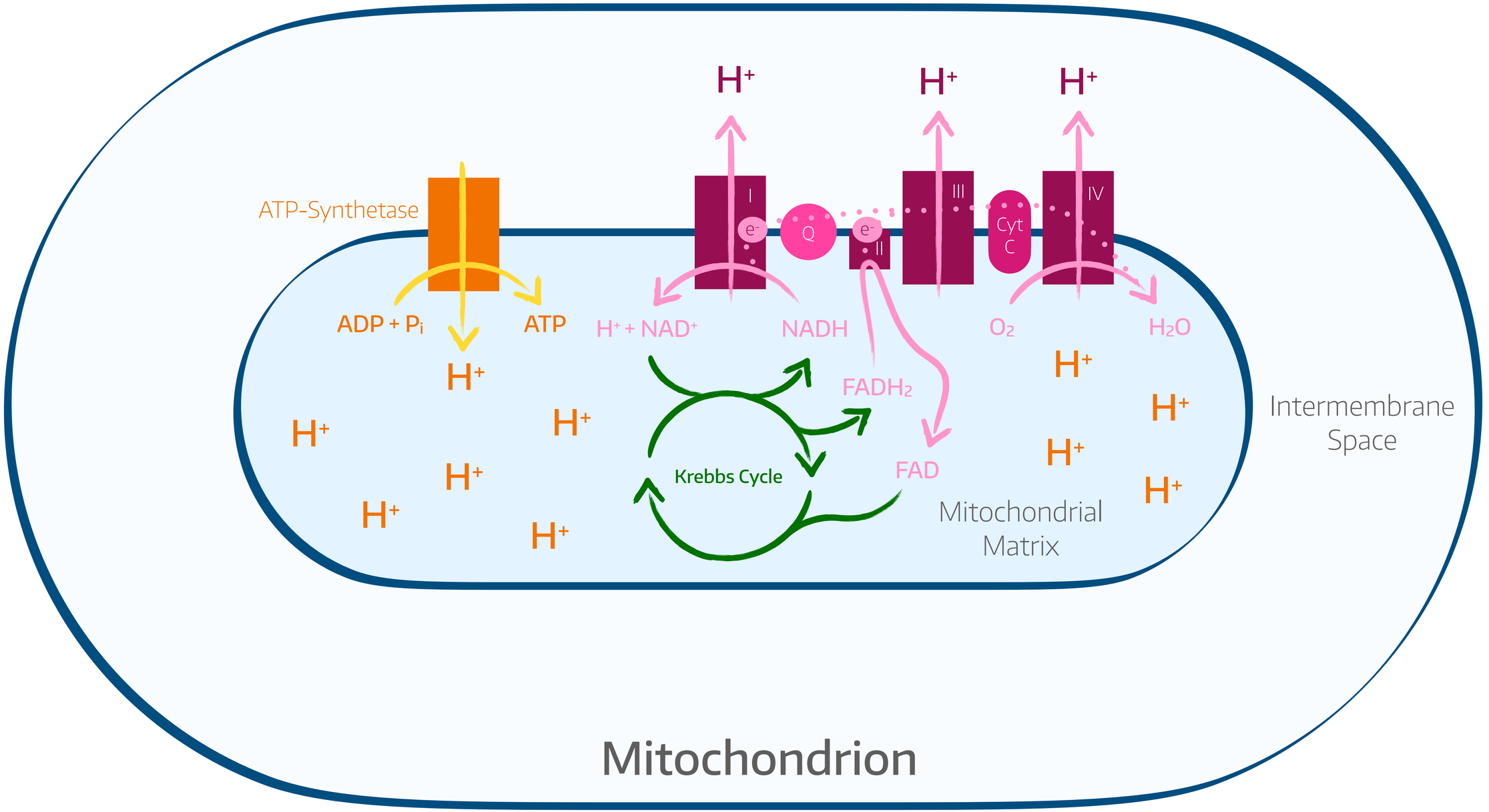
Lymphoid

- Lymphoblast
  - **B Cell**
  - **T Cell**
  - **NK Cell**

HAEMATOLOGY

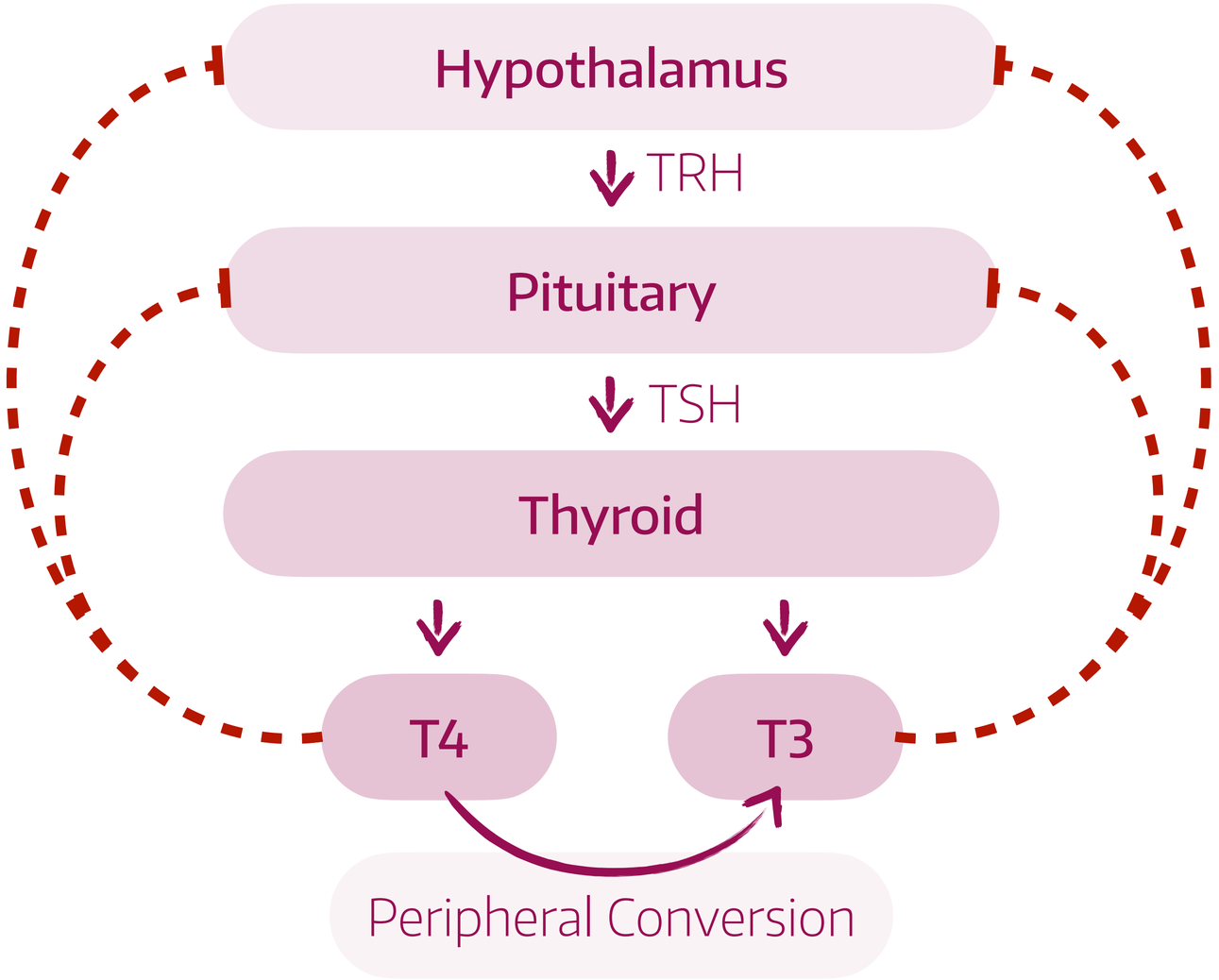


Cellular Biology



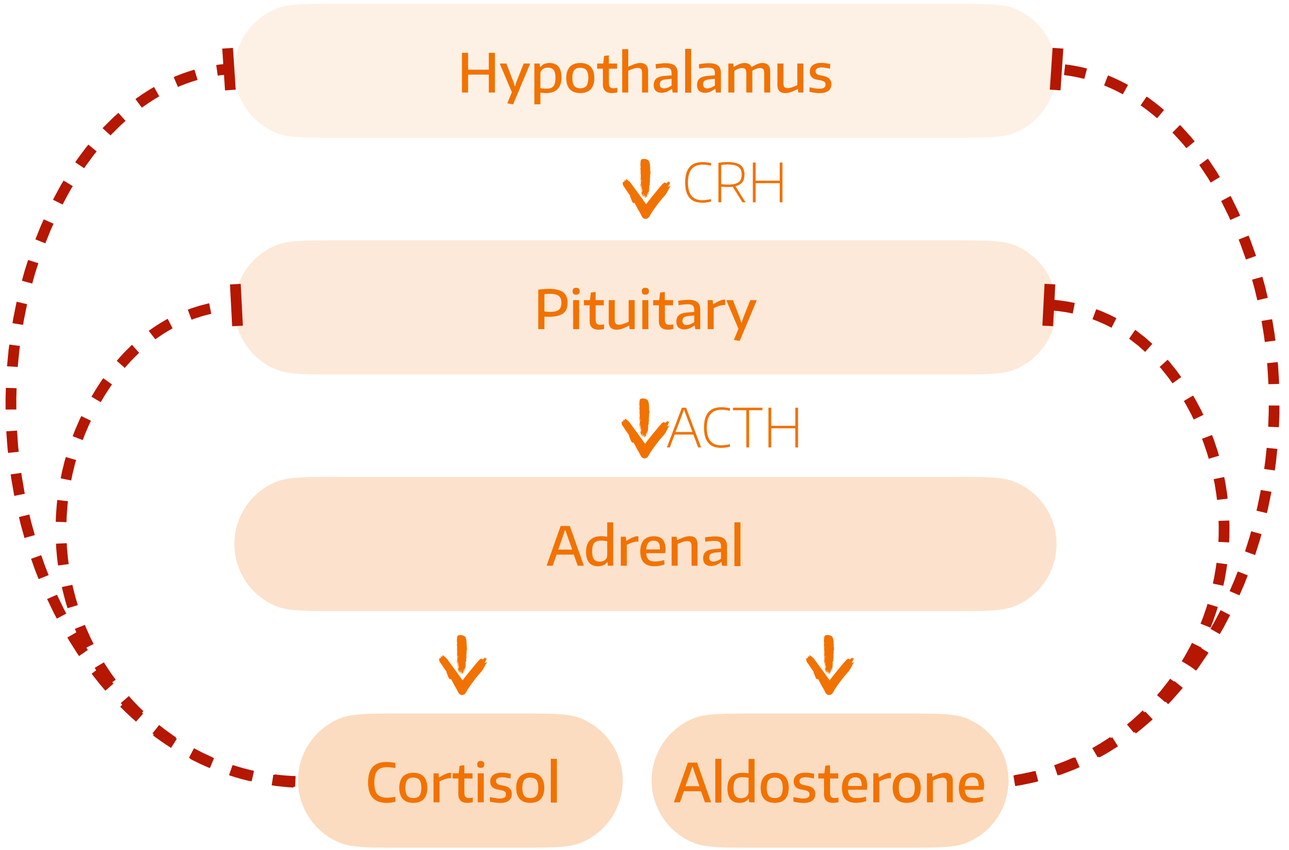
ENDOCRINOLOGY

THYROID AXIS



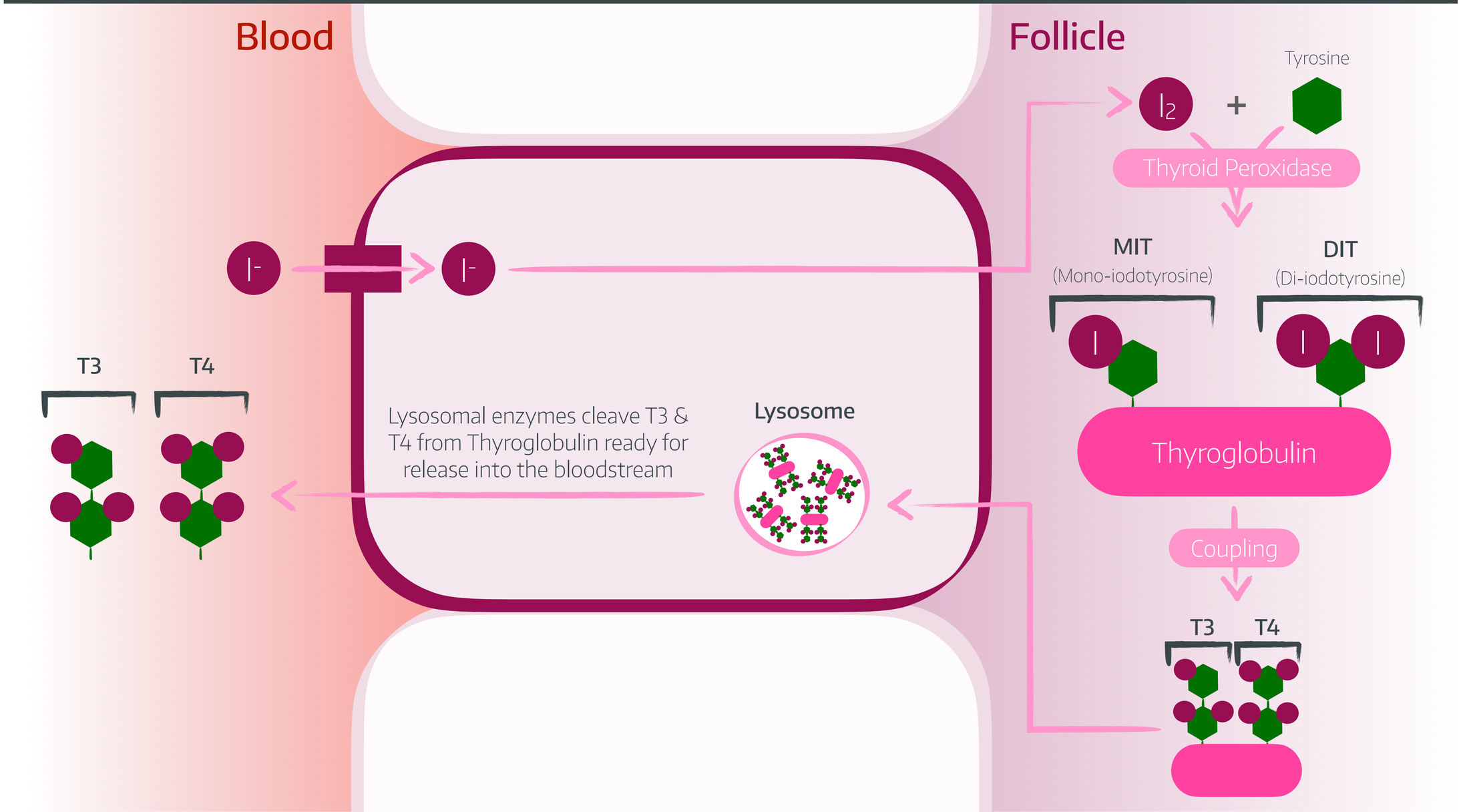
ENDOCRINOLOGY

ADRENAL AXIS



ENDOCRINOLOGY

THYROID HORMONE RELEASE

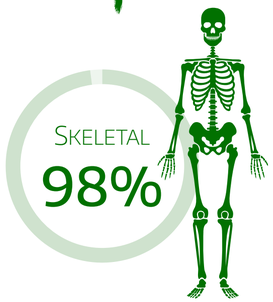


Endocrinology

Calcium

Normal Plasma Ca^{2+}: 2.2 - 2.7 $mmol.L^{-1}$

Total Body Ca^{2+}: 1200g



Skeletal 98%

As hydroxyapetite
(Calcium + Physophorus + Hydroxide)

Extracellular Fluid 1%

(Especially Muscle)

Tissues 1%

Ionised 50%

"Free"

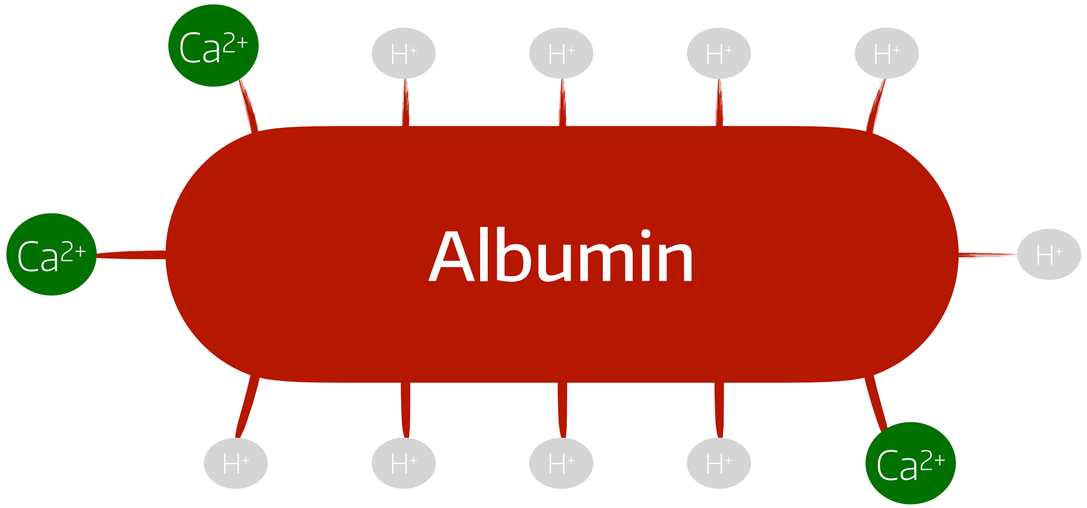
Complexed 10%

Ion Couplets with Citrate, Bicarbonate, etc.

Protein-Bound 40%

90% to Albumin
10% to Globulins

CALCIUM



Albumin has 12 Binding Sites

Usually only 10-15% of them are used up by calcium

Why does hyperventilation cause tingly fingers

If pH rises...

1) Less H^+ can compete with Ca^{2+} for albumin binding-sites
2) Albumin undergoes a conformational change
3) HCO_3^- increases

> Increased Calcium Binding reduces the Ionised Fraction

> Reduced Plasma Ca^{2+} leads to increased excitability of peripheral nerve axons

ADH Vasopressin

Endocrinology

Angiotensin II

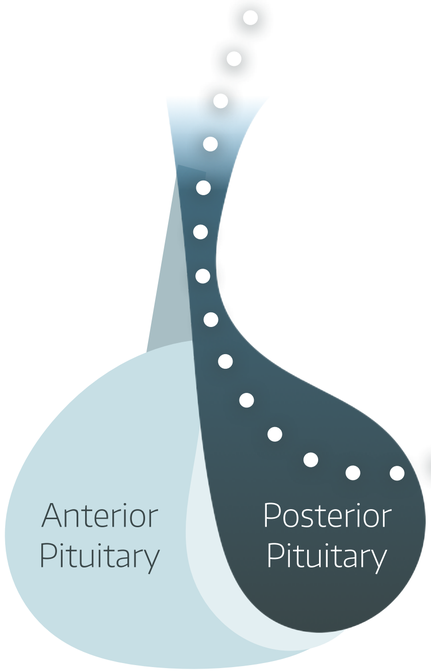
Sympathetic Nervous System

↑ Osmolality

Hypovolaemia

Hypotension

Supraoptic Nucleus of Hypothalamus



ADH

Receptors:

ADH V_1R

Vascular Smooth Muscle

Vasoconstriction

ADH V_2R

Collecting Duct (Basolateral Membrane)

Renal Fluid Absorption
(via aquaporins)

Endocrinology

Control of Hormone Release

Peptides

Examples

Insulin
Glucagon
ACTH
Gastrin

Key Points

Prohormones
Vesicles
Cell Membrane Release
Fast Onset

Steroids

Examples

Cortisol
Aldosterone
Testosterone
Oestrogen

Key Points

Cholesterol
Not stored
Carrier Proteins
Intracellular Receptors
Gene Expression
Slow & Long-Acting

Amino Acid Derivatives

Examples

Thyroid Hormones
Catecholamines
Serotonin
Melatonin

Key Points

T3 & T4 are protein-bound and have nuclear receptors

Adrenaline is polar
Adrenaline is fast-acting & has membrane receptor

Anatomy

Sacrum