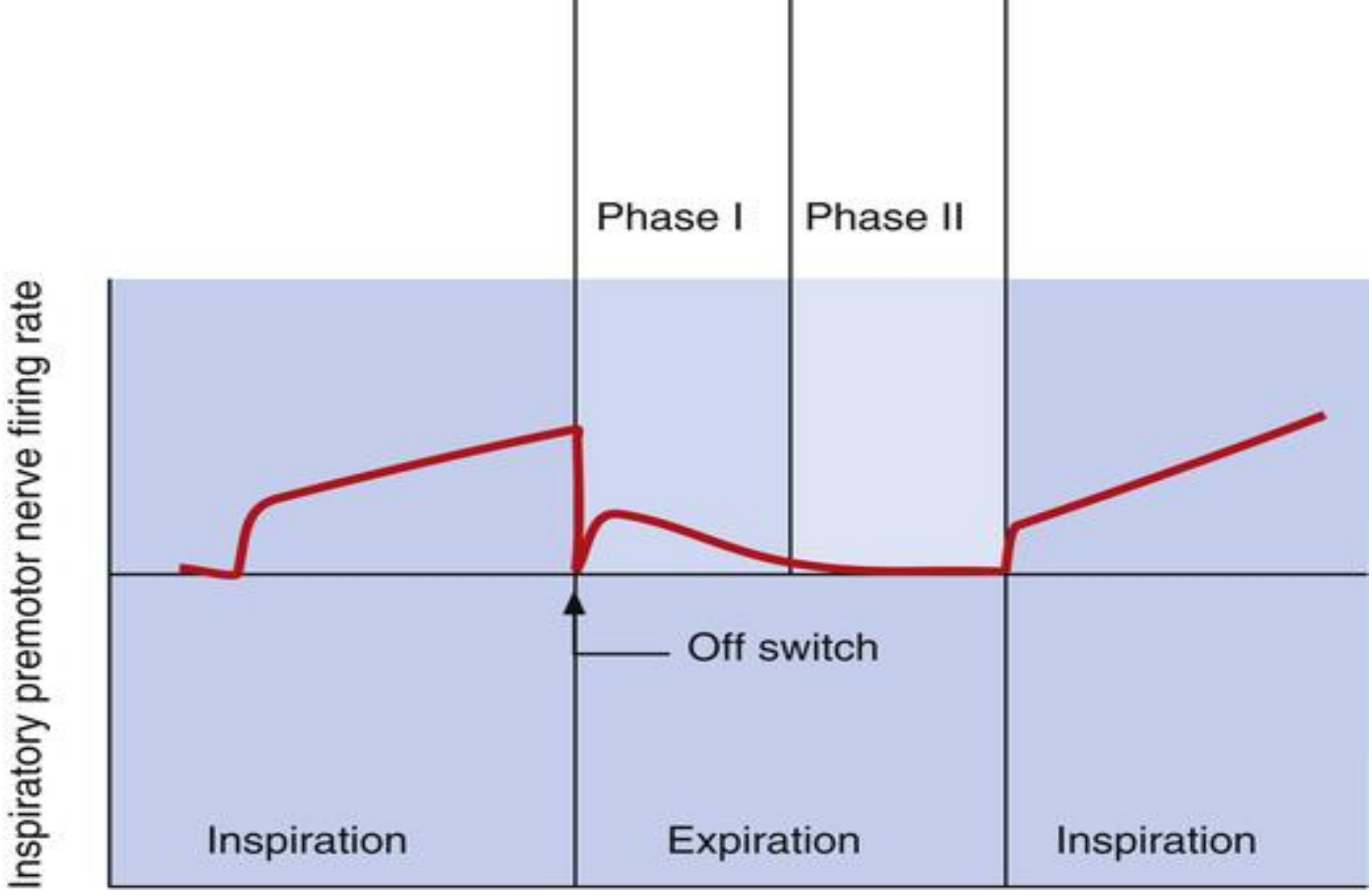
Respiration 3


Phase I
Phase II
Inspiratory premotor nerve firing rate
Off switch
Inspiration
Expiration
Inspiration

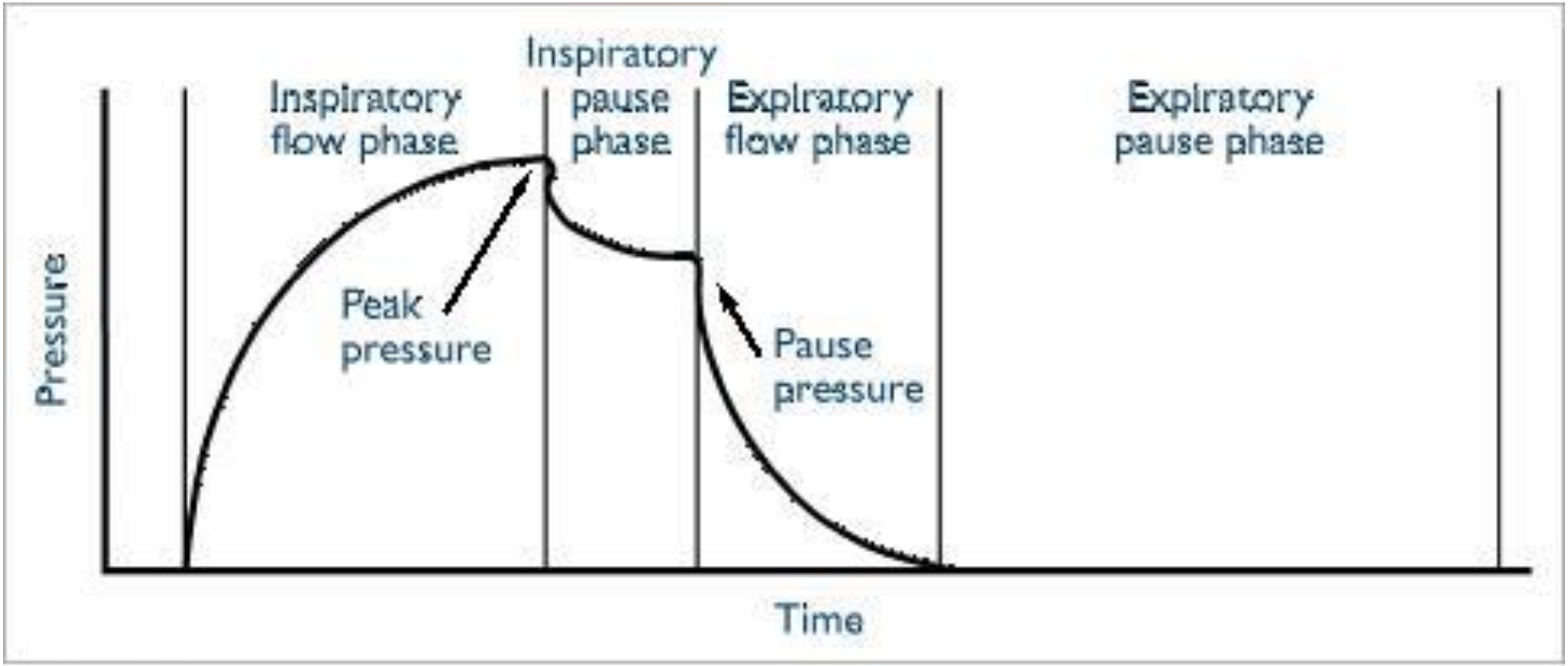
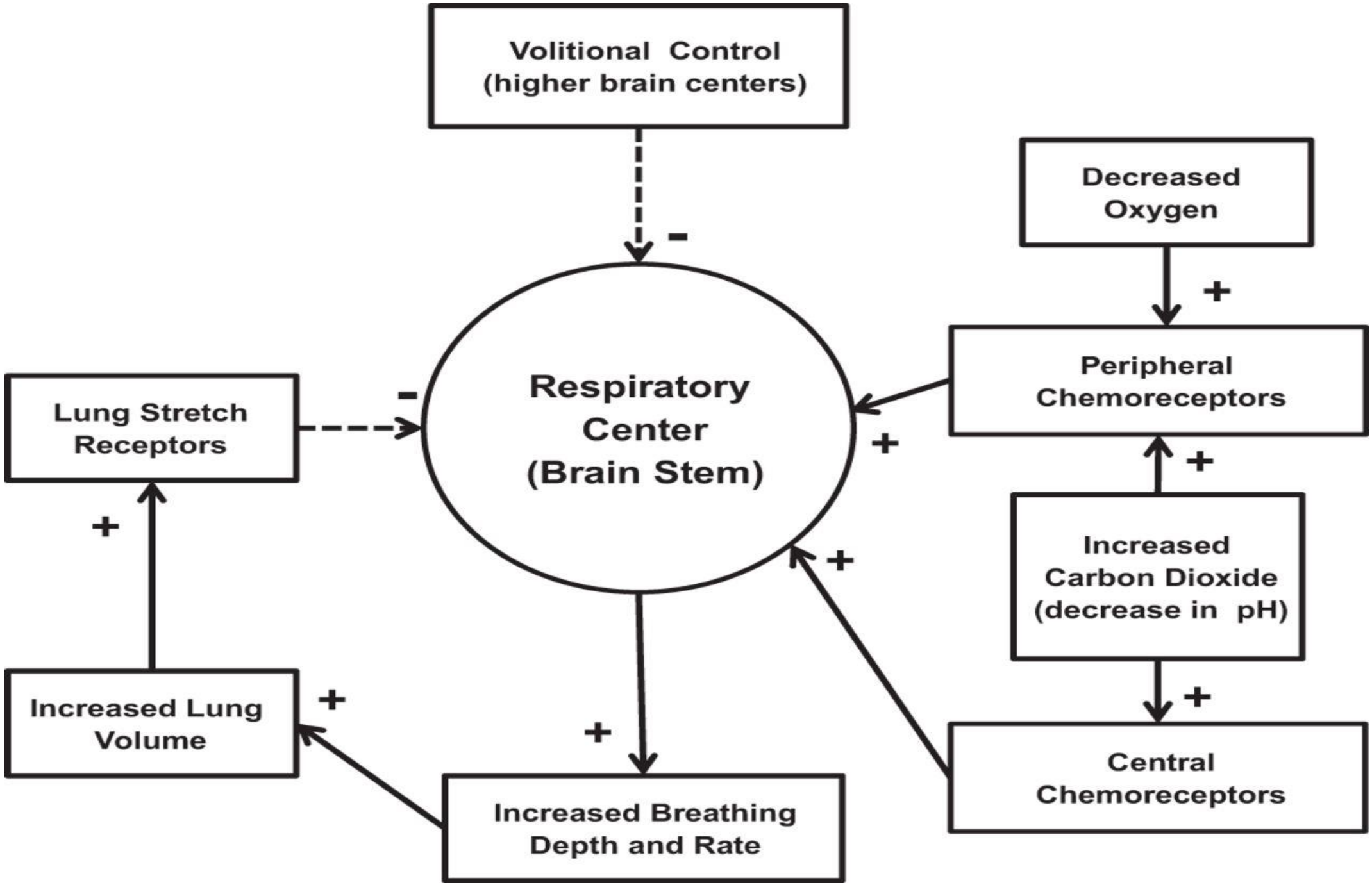
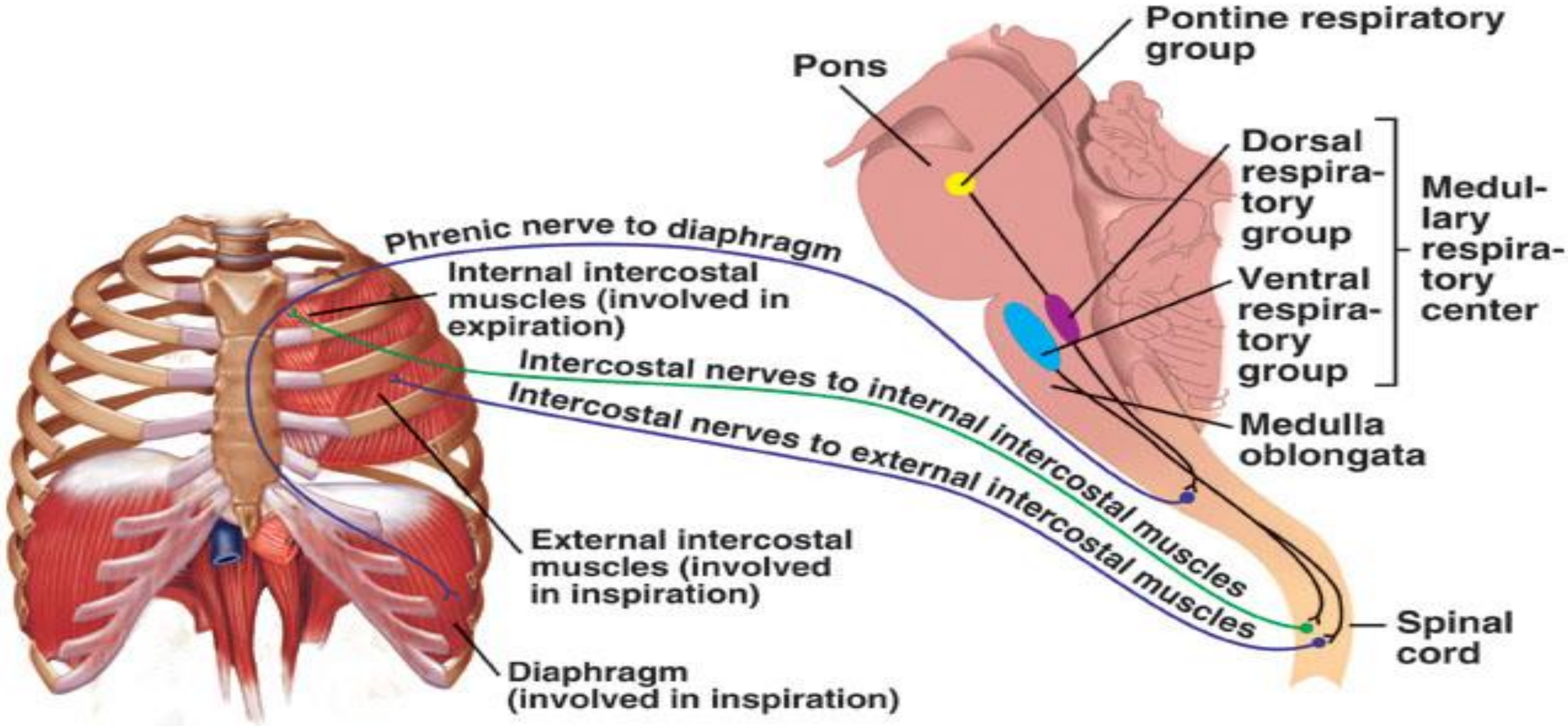
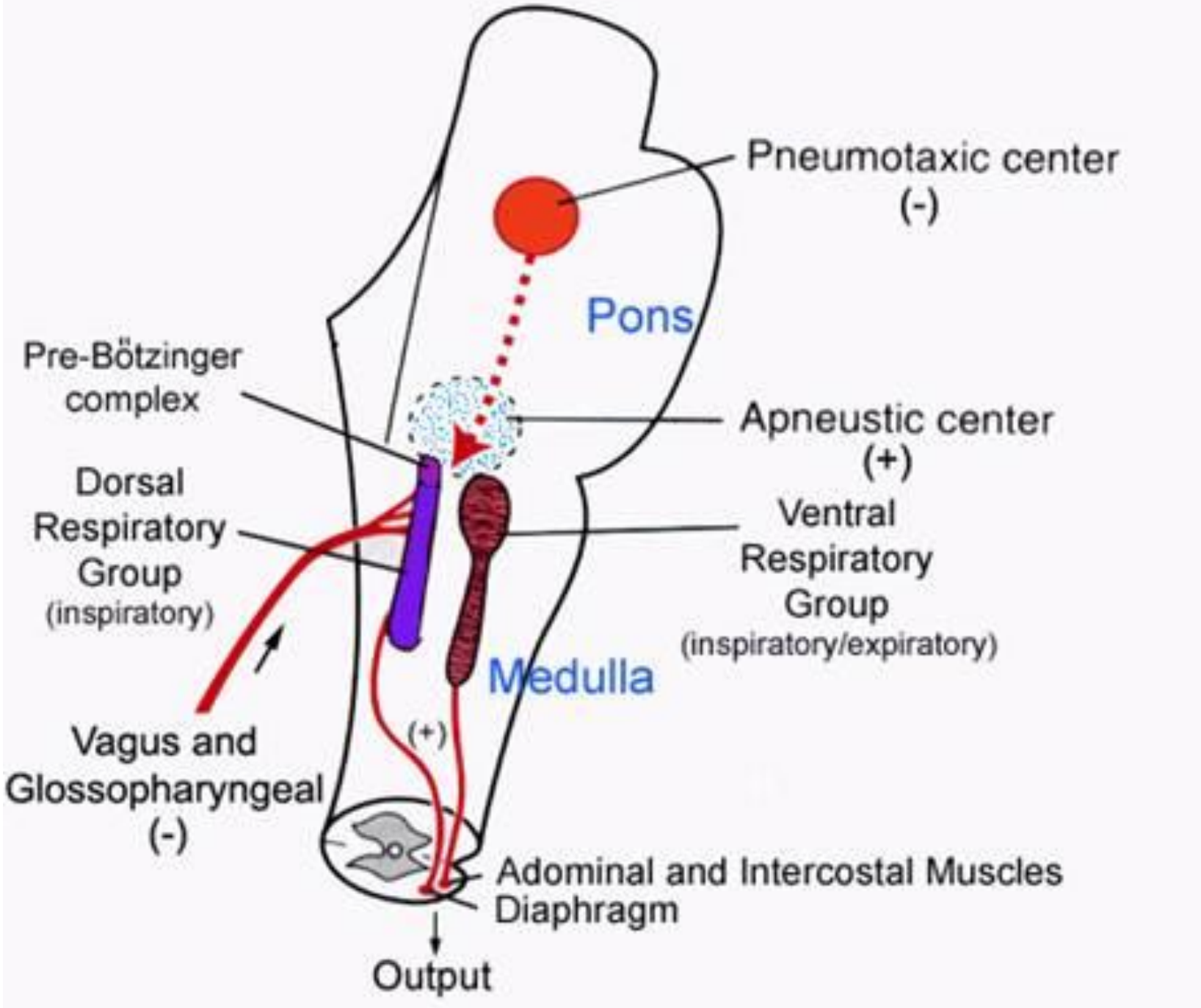
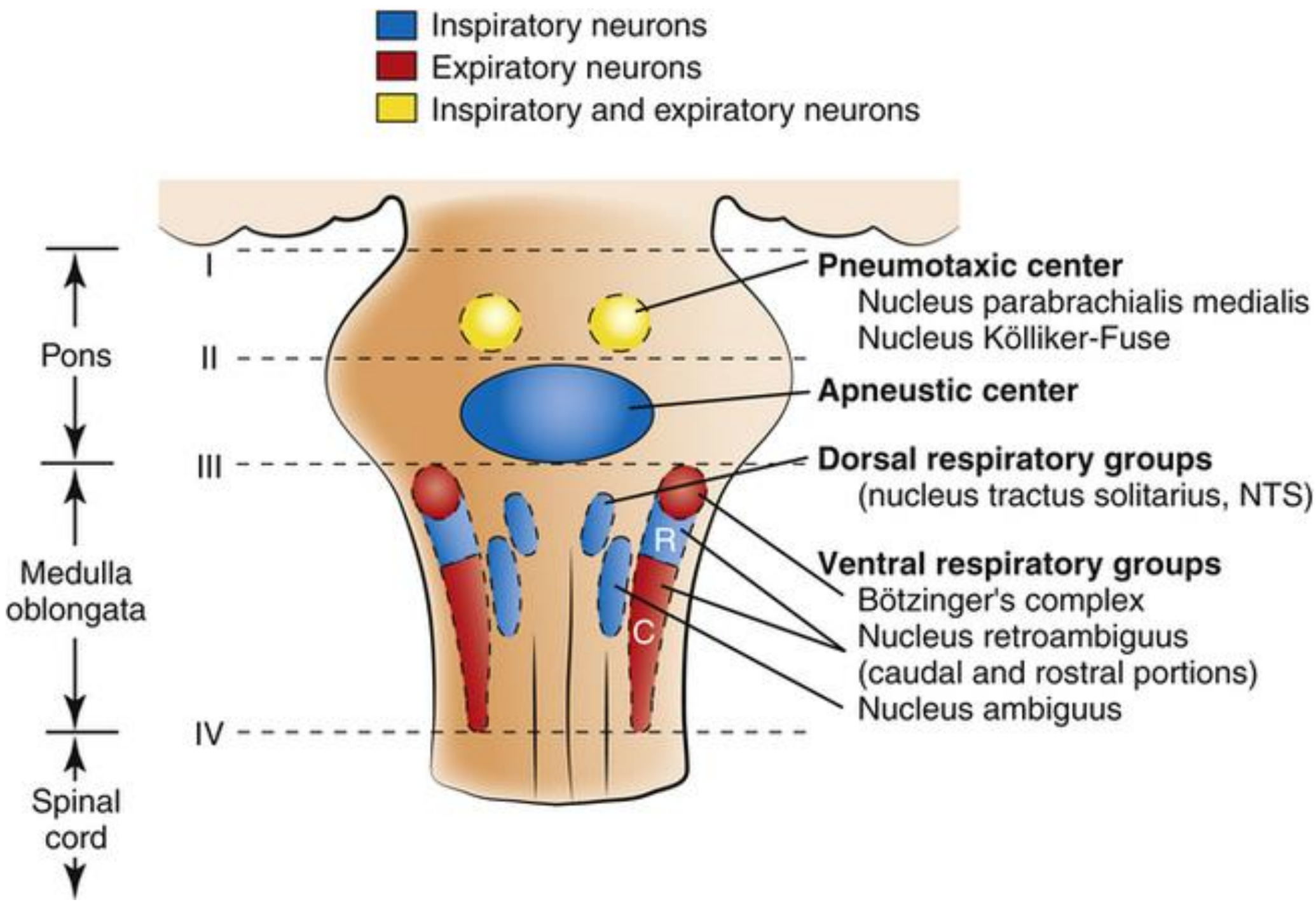


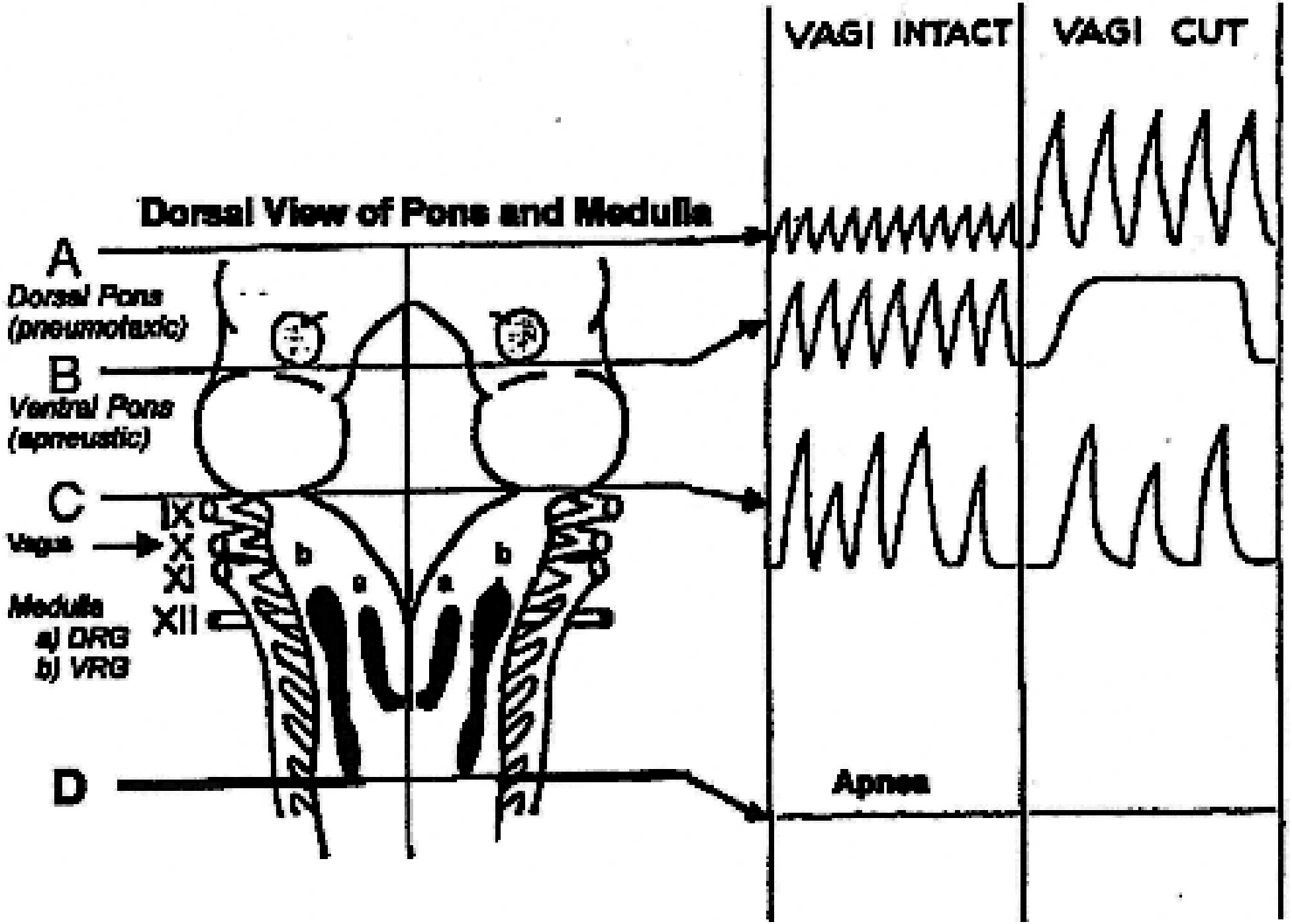
Figure 1. Phases of the respiratory cycle.[3]

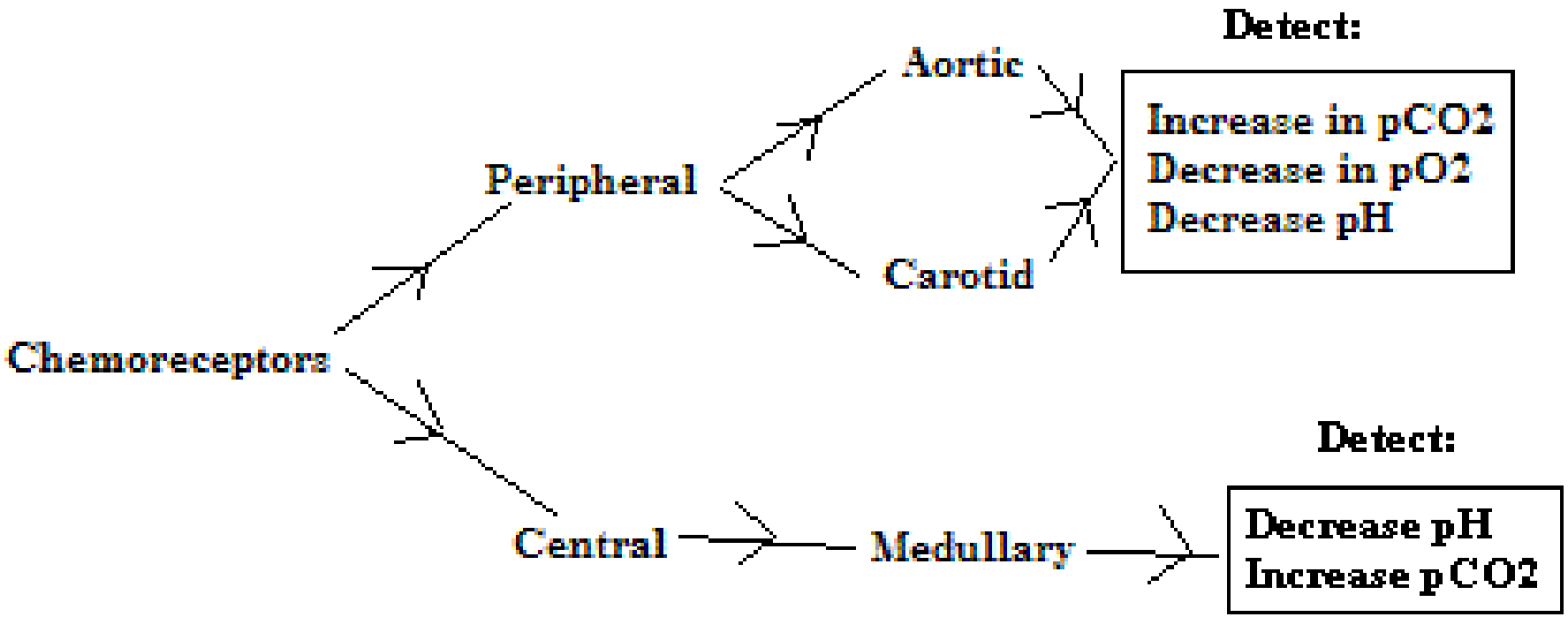

Volitional Control
(higher brain centers)
-
Decreased
Oxygen
+
Peripheral
Chemoreceptors
+
Respiratory
Center
(Brain Stem)
-
Lung Stretch
Receptors
+
Increased
Carbon Dioxide
(decrease in pH)
+
+
+
+
Increased Lung
Volume
+
Central
Chemoreceptors
+
Increased Breathing
Depth and Rate

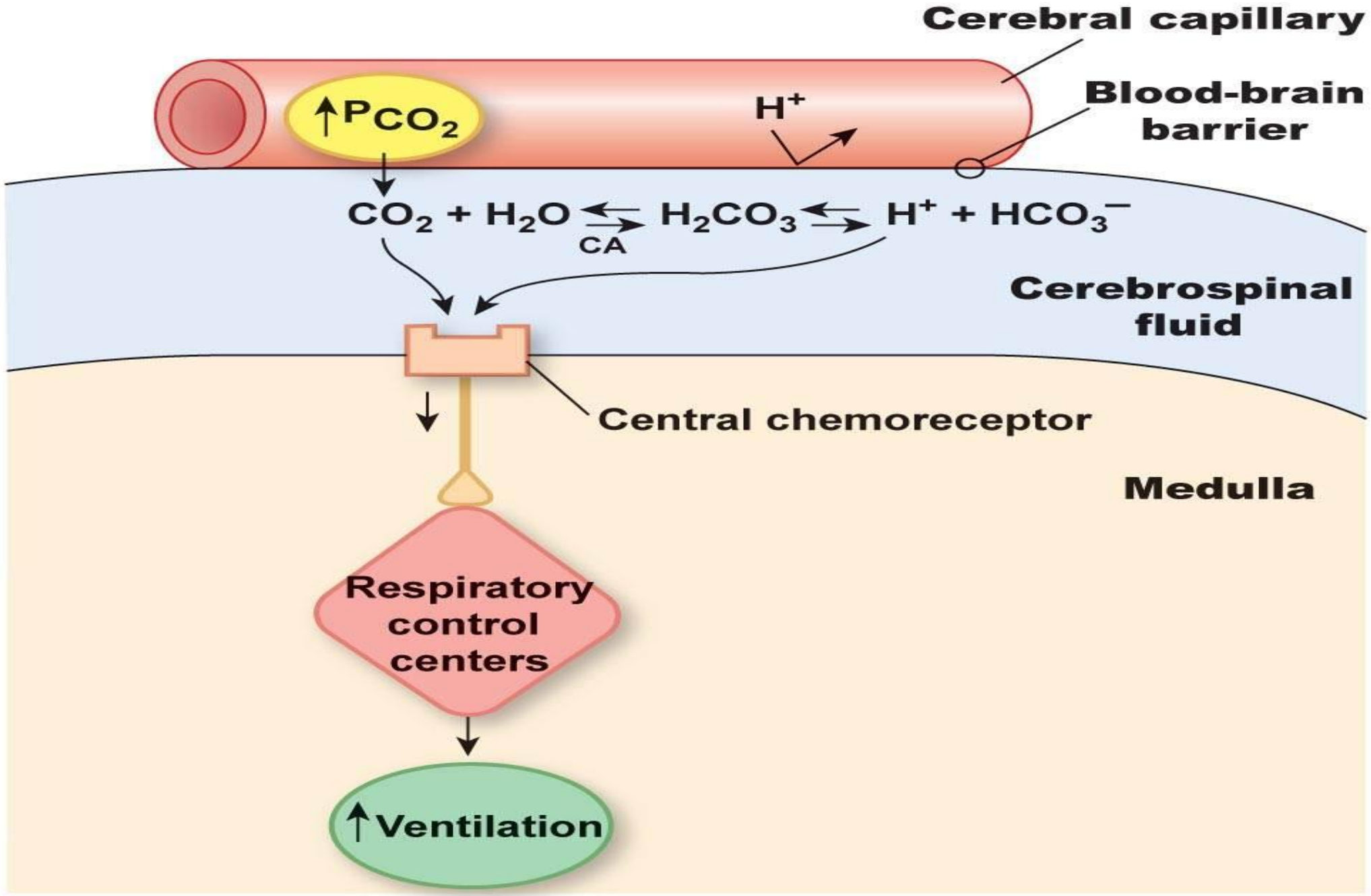


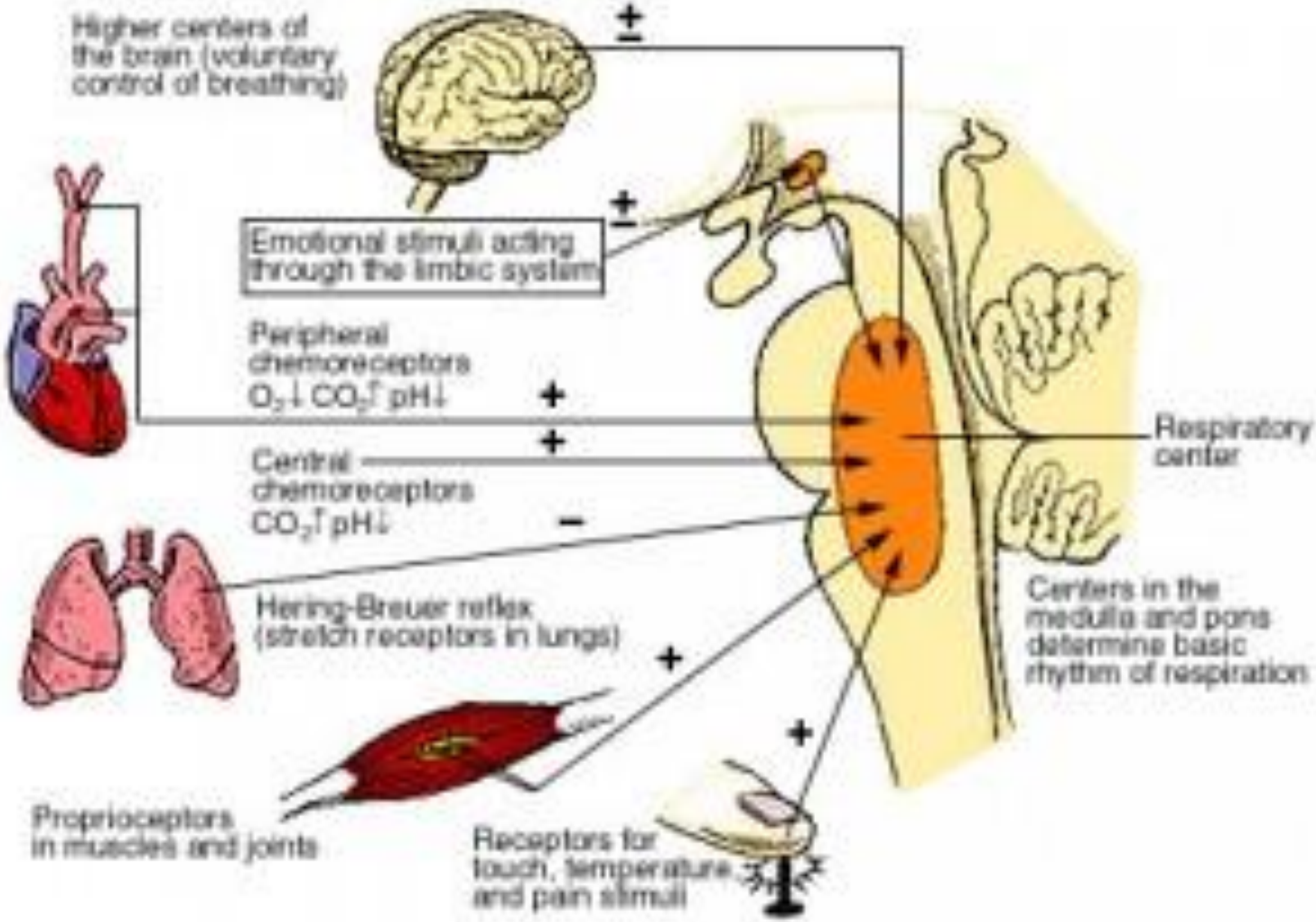

Pneumotaxic center
(-)
Pons
Pre-Bötzinger
complex
Apneustic center
(+)
Dorsal
Respiratory
Group
(inspiratory)
Ventral
Respiratory
Group
(inspiratory/expiratory)
Medulla
Vagus and
Glossopharyngeal
(-)
(+)
Adominal and Intercostal Muscles
Diaphragm
Output


Inspiratory neurons
Expiratory neurons
Inspiratory and expiratory neurons
Pons
Medulla oblongata
Spinal cord
I
II
III
IV
R
C
Pneumotaxic center
Nucleus parabrachialis medialis
Nucleus Kölliker-Fuse
Apneustic center
Dorsal respiratory groups
(nucleus tractus solitarius, NTS)
Ventral respiratory groups
Bötzinger's complex
Nucleus retroambiguus
(caudal and rostral portions)
Nucleus ambiguus


VAGI INTACT
VAGI CUT
Dorsal View of Pons and Medulla
A
Dorsal Pons
(pneumotaxic)
B
Ventral Pons
(apneustic)
C
Vagus
IX
X
XI
XII
Medulla
a) DRG
b) VRG
D
Apnea


Detect:
Aortic
Peripheral
Carotid
Increase in pCO2
Decrease in pO2
Decrease pH
Chemoreceptors
Detect:
Central
Medullary
Decrease pH
Increase pCO2




Higher centers of the brain (voluntary control of breathing)
±
Emotional stimuli acting through the limbic system
±
Peripheral chemoreceptors
$O_2\downarrow CO_2\uparrow pH\downarrow$
+
Central chemoreceptors
$CO_2\uparrow pH\downarrow$
+
Hering-Breuer reflex (stretch receptors in lungs)
−
Proprioceptors in muscles and joints
+
Receptors for touch, temperature and pain stimuli
+
Respiratory center
Centers in the medulla and pons determine basic rhythm of respiration

Non chemical regulation
(stimulus- receptor- afferent- response)

1. Higher brain centers:

Voluntary control- voluntary hyperventilation- voluntary apnea (breaking point!!)

2. Upper airways receptors: Sneezing – coughing-
3. Lung receptors:

Lung inflation- lung irritant – J-receptor reflex

4. Chest wall receptors
5. Proprioceptors
6. Cardiovascular: arterial baroreceptors- atrial stretch receptors
7. Visceral : swallowing- hiccup

Types of Hypoxia

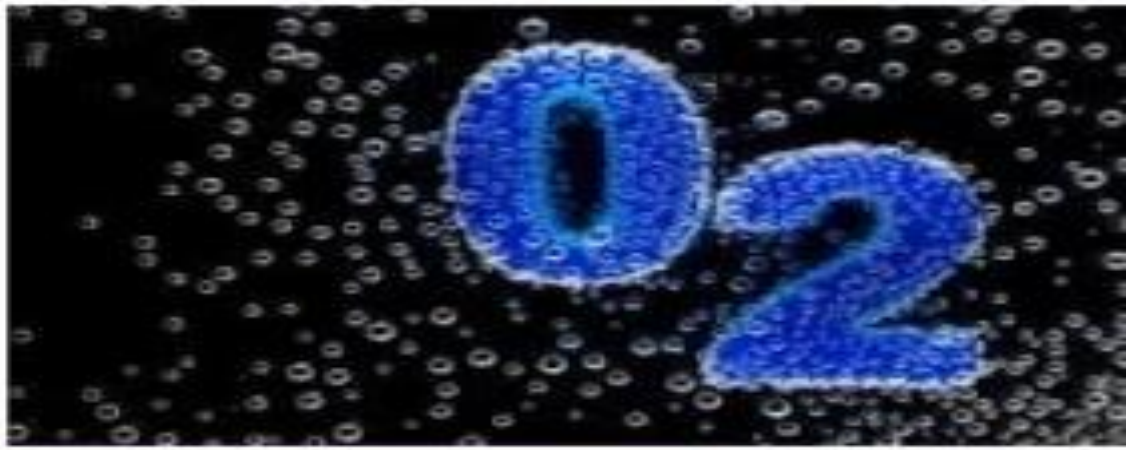
hypoxic hypoxia

hypemic hypoxia

stagnant hypoxia

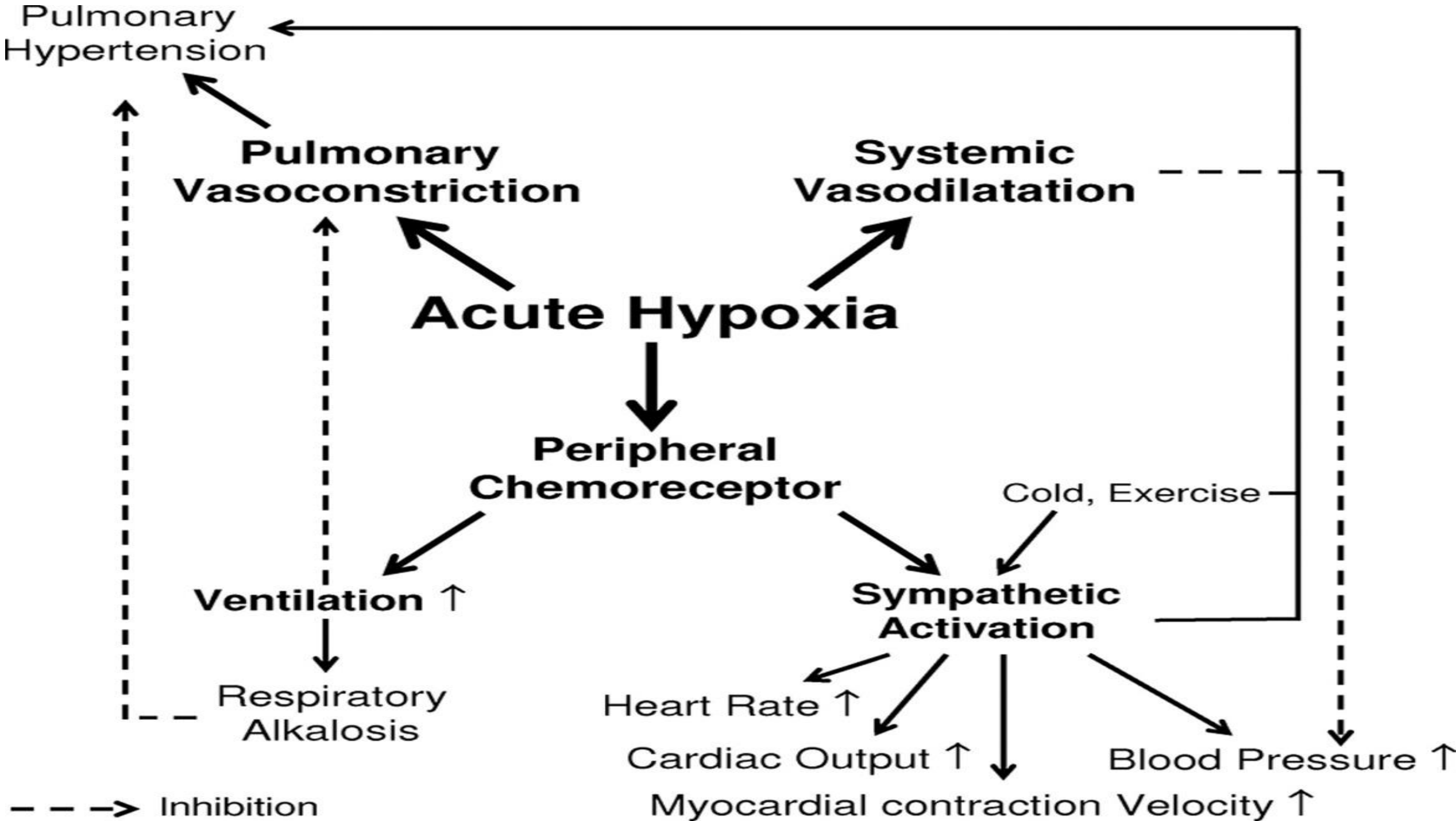
histotoxic hypoxia

Types of hypoxia



Types	Definintion	Typical cases
Hypoxic	⇩ oxygen tension	High altitude – hypoventilation – V/Q mismatch.
Anemic	⇩ carrying capacity	Anemia – blood loss – CO poisoning
Stagnant	⇩ perfusion	Heart failure – Shock – ischemia
Histotoxic	Cellular hypoxia	Cyanide – other metabolic poisons – shifting of O2-HB curve.

	PaO2	PvO2	Oxygen content	Oxygen therapy	Cyanosis
Hypoxic hypoxia	↓	↓	↓	✔	✔
Anemic hypoxia	Normal	↓	↓	~	
Stagnant hypoxia	Normal	↓		~	✔
Histotoxic hypoxia	Normal	↑		✖	


Pulmonary Hypertension
Pulmonary Vasoconstriction
Systemic Vasodilatation
Acute Hypoxia
Peripheral Chemoreceptor
Cold, Exercise
Ventilation ↑
Sympathetic Activation
Respiratory Alkalosis
Heart Rate ↑
Cardiac Output ↑
Blood Pressure ↑
Myocardial contraction Velocity ↑
Inhibition