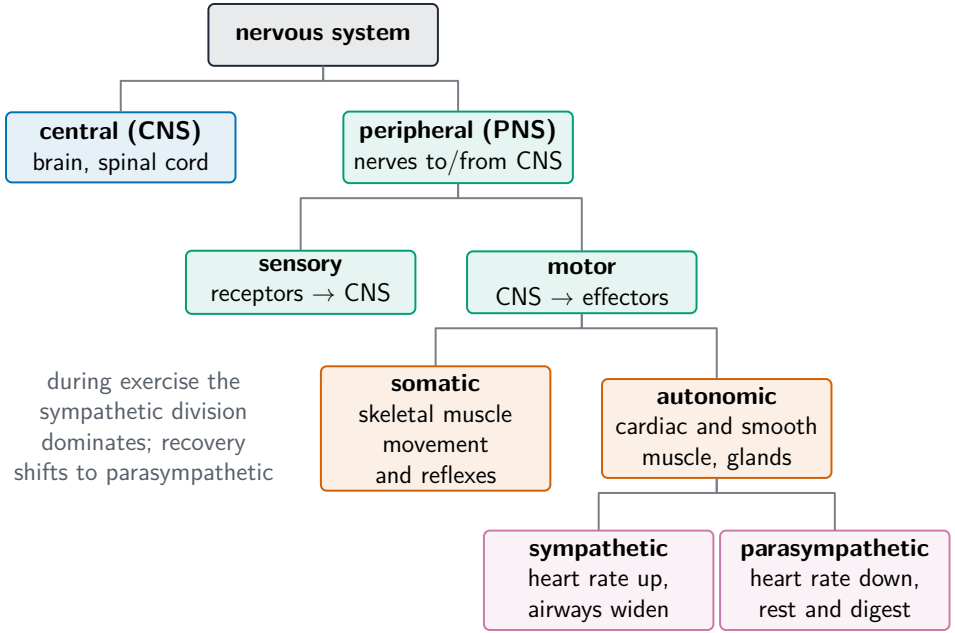
Exercise walk-through

1.2
The heart, lungs and homeostasis

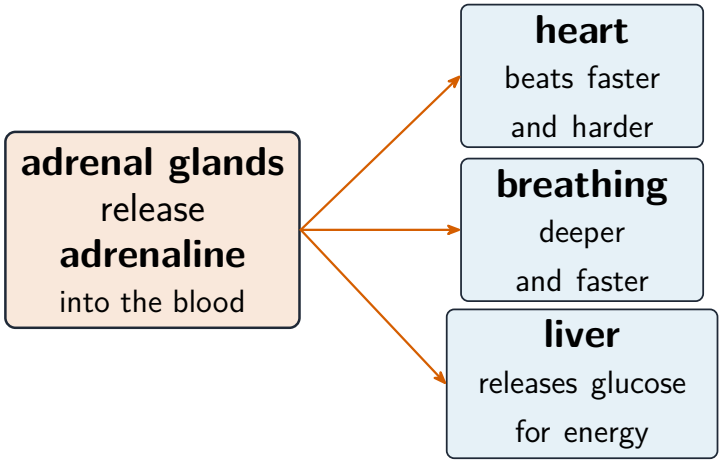
International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · HL

Divisions of the nervous system



> Somatic control includes automatic skeletal-muscle reflexes.

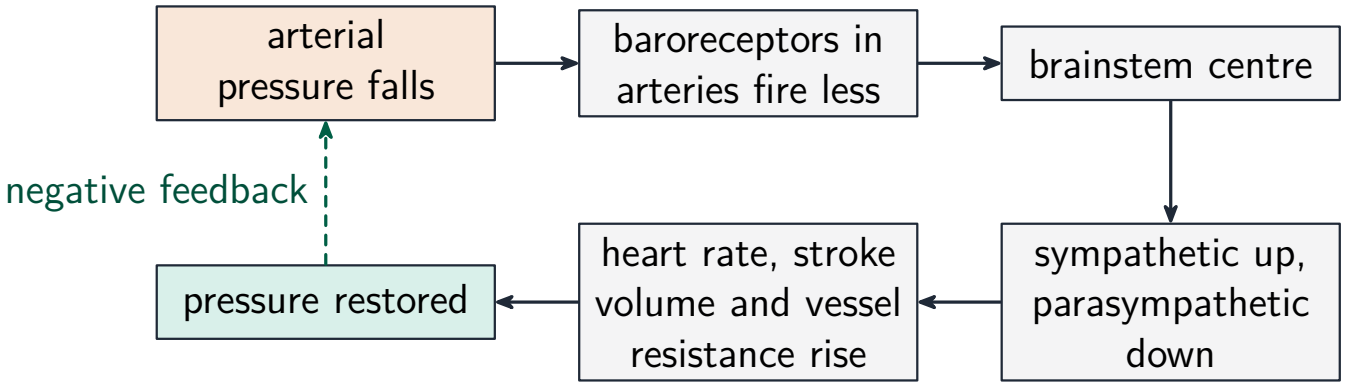
Adrenaline prepares for action



all of this
prepares the body for action
("fight or flight")

One **hormone** acts on many targets

The baroreflex



the SA node sets the rhythm; these signals only modify it

Heart rate, **stroke volume** and resistance rise, restoring pressure

Exercises 2.1·2.2

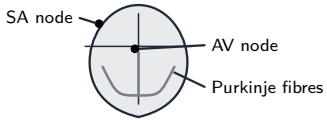
2.1 An athlete has a heart rate of 150 beats min^{-1} and a stroke volume of 120 ml. Calculate the cardiac output in L min^{-1}. [2]



HR 150 beats min^{-1}

SV 120 ml

2.2 Describe how the electrical impulse that starts each heartbeat spreads through the heart. [3]



Exercises 2.1·2.2

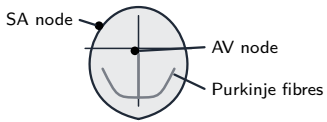
2.1 An athlete has a heart rate of 150 beats min^{-1} and a stroke volume of 120 ml. Calculate the cardiac output in L min^{-1}. [2]



2.1

$Q = 150 \times 120 = 18\,000$ ml min^{-1} = **18** L min^{-1}

2.2 Describe how the electrical impulse that starts each heartbeat spreads through the heart. [3]



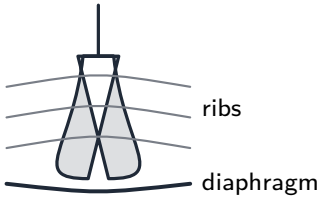
2.2

the impulse starts at the SA node and spreads over the atria, which contract; it reaches the AV node, which delays it so the ventricles can fill; it passes down the bundle of His and through the Purkinje fibres, so the ventricles contract from the bottom up

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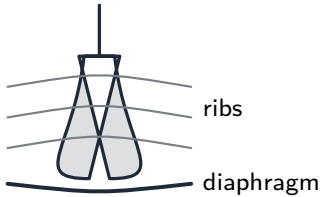
Exercise 2.3

2.3 Describe the mechanics of breathing in at rest. [3]



Exercise 2.3

2.3 Describe the mechanics of breathing in at rest. [3]



2.3

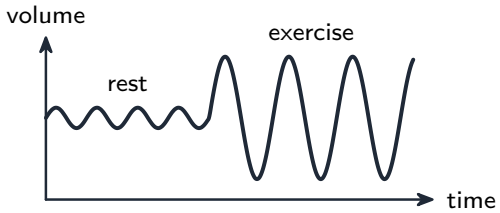
the diaphragm contracts and flattens; the external intercostal muscles contract, moving the ribs up and out; chest volume rises so pressure in the lungs falls below air pressure, and air flows in

Exercise 2.4 (a)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
hard exercise	2.5	40

(a) Calculate the minute ventilation at rest and in exercise. [2]

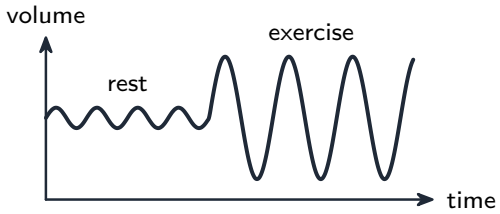


Exercise 2.4 (a)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
hard exercise	2.5	40

(a) Calculate the minute ventilation at rest and in exercise. [2]



(a) rest $0.5 \times 12 = \mathbf{6}$ L min^{-1}; exercise $2.5 \times 40 = \mathbf{100}$ L min^{-1}

Exercise 2.4 (b)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
hard exercise	2.5	40

(b) Calculate how many times larger it is in exercise. [1]

Exercise 2.4 (b)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
hard exercise	2.5	40

(b) Calculate how many times larger it is in exercise. [1]

(b) $100 \div 6 \approx$ **17** times

Exercise 2.4 (c)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
hard exercise	2.5	40

(c) Name the receptors that detect the rise in blood CO_2. [1]

Exercise 2.4 (c)

2.4 The table shows breathing data for a student.

	tidal volume (L)	**breaths min^{-1}**
rest	0.5	12
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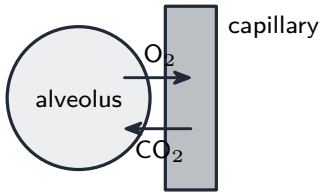
(c) Name the receptors that detect the rise in blood CO_2. [1]

(c) chemoreceptors

Exercise 3.1 (a)

3.1 The diagram shows an alveolus and a capillary.

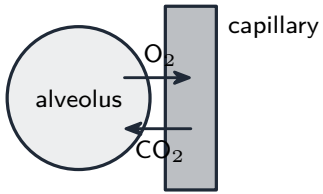
(a) Explain how oxygen moves from the alveolus into the blood. [2]



Exercise 3.1 (a)

3.1 The diagram shows an alveolus and a capillary.

(a) Explain how oxygen moves from the alveolus into the blood. [2]



(a) by diffusion; from a higher partial pressure of O_2 in the alveolus to a lower partial pressure in the blood

Exercise 3.1 (b)

3.1 The diagram shows an alveolus and a capillary.

(b) Explain **two** features of the alveoli that make gas exchange fast. [2]

Exercise 3.1 (b)

3.1 The diagram shows an alveolus and a capillary.

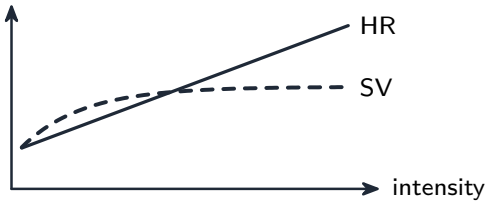
(b) Explain **two** features of the alveoli that make gas exchange fast. [2]

(b) any two, explained: walls one cell thick, so a short diffusion distance; a huge surface area; dense capillary network keeps the gradient high; moist lining

Exercise 3.2 (a)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

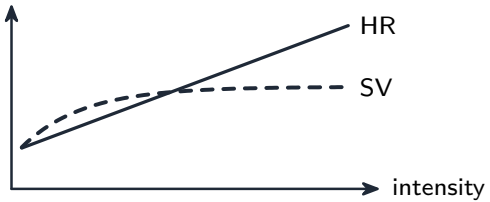
(a) Describe how stroke volume changes as intensity rises. [2]



Exercise 3.2 (a)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

(a) Describe how stroke volume changes as intensity rises. [2]



(a) stroke volume rises at low to moderate intensity; then levels off (plateau) at about 40–60% of maximum

Exercise 3.2 (b)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

(b) Explain why heart rate rises just before exercise starts. [2]

Exercise 3.2 (b)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

(b) Explain why heart rate rises just before exercise starts. [2]

(b) anticipation of exercise activates the sympathetic system; adrenaline is released and raises heart rate (anticipatory rise)

Exercise 3.2 (c)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

(c) Explain how venous return increases during exercise. [2]

Exercise 3.2 (c)

3.2 The graph shows stroke volume and heart rate as exercise intensity rises.

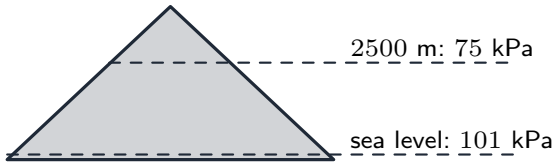
(c) Explain how venous return increases during exercise. [2]

(c) any two: muscle pump: contracting muscles squeeze veins, with valves stopping backflow; respiratory pump: pressure changes in the chest during deeper breathing; venoconstriction

Exercise 3.3 (a)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

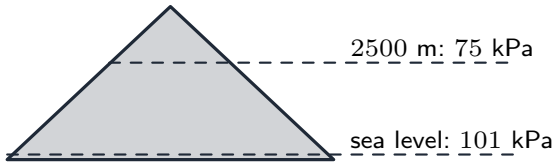
(a) Calculate the partial pressure of oxygen at sea level and at 2500 m. [2]



Exercise 3.3 (a)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(a) Calculate the partial pressure of oxygen at sea level and at 2500 m. [2]



(a) sea level $0.209 \times 101 = \mathbf{21.1}$ kPa; altitude $0.209 \times 75 = \mathbf{15.7}$ kPa

Exercise 3.3 (b)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(b) Explain why less oxygen enters the blood at altitude. [2]

Exercise 3.3 (b)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(b) Explain why less oxygen enters the blood at altitude. [2]

(b) the partial pressure of O_2 in the alveoli is lower; so the gradient between alveoli and blood is smaller and less O_2 diffuses in / haemoglobin is less saturated

Exercise 3.3 (c)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(c) Describe **two** adaptations after several weeks at altitude. [2]

Exercise 3.3 (c)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(c) Describe **two** adaptations after several weeks at altitude. [2]

(c) any two: more EPO, so more red blood cells and haemoglobin; more capillaries in muscle; higher breathing rate; more mitochondria / myoglobin

Exercise 3.3 (d)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(d) Explain how heat acclimatization helps an athlete compete in a hot climate. [2]

Exercise 3.3 (d)

3.3 A team trains at 2500 m, where air pressure is about 75 kPa (sea level: 101 kPa). Air is 20.9% oxygen at both heights.

(d) Explain how heat acclimatization helps an athlete compete in a hot climate. [2]

(d) sweating starts earlier and more sweat is produced, so more heat is lost; plasma volume rises, so stroke volume stays higher and heart rate is lower at the same work