Department of
Education

GOVERNMENT OF
WESTERN AUSTRALIA

Year 12 ATAR Human Biology

Unit 3: Homeostasis

Homeostasis
workbook

Year 12 ATAR Human Biology

UNIT 3
HOMEOSTASIS

Feedback Models; Homeostasis of body temperature, body fluids, blood sugar levels and gas concentrations, Disruptions to homeostasis

Duration: 3 weeks

Table of Contents

Syllabus points covered in this booklet

Science Understanding – Homeostasis

- *Homeostatic processes involve nerves and hormones in maintaining the body's internal environment within tolerance limits through the control of metabolism and physiological and behavioural activities*
- *Thermoregulation occurs by the control of heat exchange and metabolic activity through physiological and behavioural mechanisms*
- *Body fluid concentrations are maintained by balancing water and salts via the skin, digestive system and the kidneys, which involve the actions of antidiuretic hormone (ADH) and aldosterone on the nephron, and the thirst reflex*
- *Blood sugar levels are maintained by controlling of sugar uptake, its storage and release by cells and use in metabolism; these processes involve the hormones of the pancreas and adrenal glands*
- *Gas concentrations are controlled by balancing the intake of oxygen and the removal of carbon dioxide via the lungs, through the actions of the medulla oblongata and the autonomic nervous system*
- *Science Inquiry Skills*
- *Select, use and/or construct appropriate representations, including diagrams, models and flow charts, to communicate conceptual understanding, solve problems and make predictions.*

Homeostasis via feedback systems

A steady internal state makes it possible for our cells to operate at their optimum level. Changes that occur in the external environment affect the internal environment, which is being continually adjusted in response.

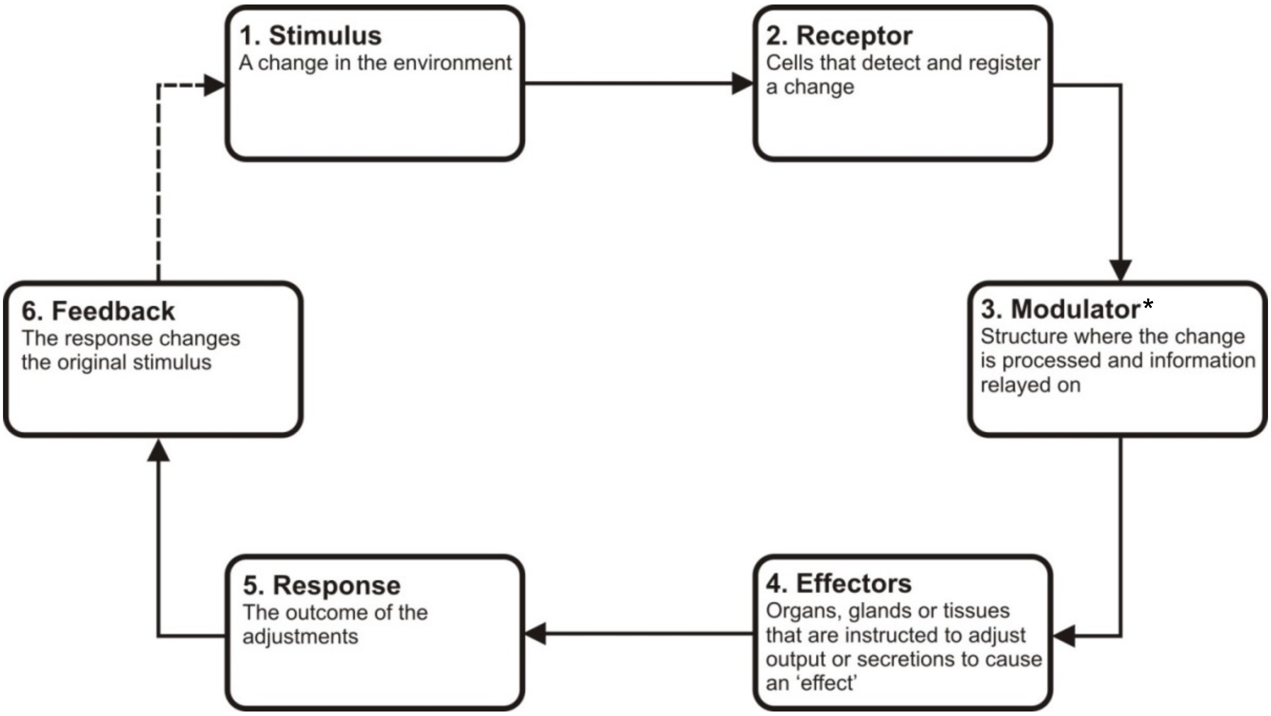
A **stimulus-response feedback model** is a good way of showing how mechanisms are operating in the body in order to maintain **homeostasis**.

Things to remember about this model:

- the loop represents a continuous process so there is no starting or finishing point
- the response alters the original stimulus.

A **negative feedback** model can be represented with six boxes, all linked in a circular arrangement with arrows. The first box represents the starting point of the feedback loop. It contains the **stimulus** or change in the environment. The second box which is linked by an arrow contains the **receptor** or the cells that detect the change. The third box contains the **modulator** which is where the change is processed and information relayed on. The fourth box contains the **effector** which is organs, glands or tissues that are instructed to adjust output or secretions to cause an effect. This is linked by an arrow to the **response** which is the change or outcome of the adjustments. The last box is the **feedback** in which the response changes the original stimulus. The arrow that links the feedback box back to the stimulus box is a "dashed" or "broken line" arrow. Negative feedback is where the response removes the initial stimulus. Most homeostatic feedback models have negative feedback as this keeps the internal environment at a fairly steady state. Some have positive feedback in which the response reinforces or intensifies the stimulus.

The following diagram reveals a **stimulus-response feedback model**. Use this diagram to answer the questions below.



***Note:** A Modulator is sometimes also called a Control Centre due to its control over the Effectors. Modulators may be part of the endocrine system or nervous system or may involve both these systems.

Activity

Complete the following questions. You can check your answers in the solutions section of this booklet.

1. Why are five arrows represented buy a solid line and one by a broken line?

   ____

2. Name an organ which contains receptors.

   ____

3. Give an example of a stimulus

   ____

4. Suggest two examples of an effector

   ____

Homeostatic mechanisms

The human body is regulated by mechanisms that involve organs, glands, tissues and cells. The constant monitoring and adjusting of these contribute to homeostasis, which enables the body to function at an optimum steady state. You will explore four major homeostatic mechanisms.

These homeostatic mechanisms control:

- body temperature
- body fluid composition
- blood sugar
- gas concentrations

Regulation of Body Temperature

As humans, we maintain a relatively constant internal body temperature independent of the external temperature. The internal temperature of humans is approximately 37°C. Any organism that can control its internal temperature is known as homeothermic.

Why is it so important to maintain a constant internal temperature?

Metabolic processes require an optimal temperature. At temperatures higher or lower than 37°C, enzymes will not function optimally. Too high - they **denature**, too low - they will slow down the rate at which metabolic processes proceed. A rise of just 2°C will cause disruption to the internal functioning of a human and should the temperature rise between 43°C and 45°C, death may occur. Our tolerance to lower temperatures is much greater. The temperature needs to fall below 23°C to cause death.

How do we lose and gain heat?

The four methods of heat transfer in and out of the body are:

- conduction
- convection
- radiation
- evaporation.

Activity

Choose the correct method of heat transfer for each of the examples below:

1. Involves heat transfer via water or air currents

 ____

2. Involves heat transferring from one object to another through direct contact

 ____

3. Involves heat transfer across space and doesn't require contact between two objects

 ____

4. Involves heat transferring out of a body as a result of a liquid converting to a gas

 ____

Heat gain versus heat loss

In order to maintain a constant body temperature, we must balance heat gain with heat loss.

How do we achieve this?

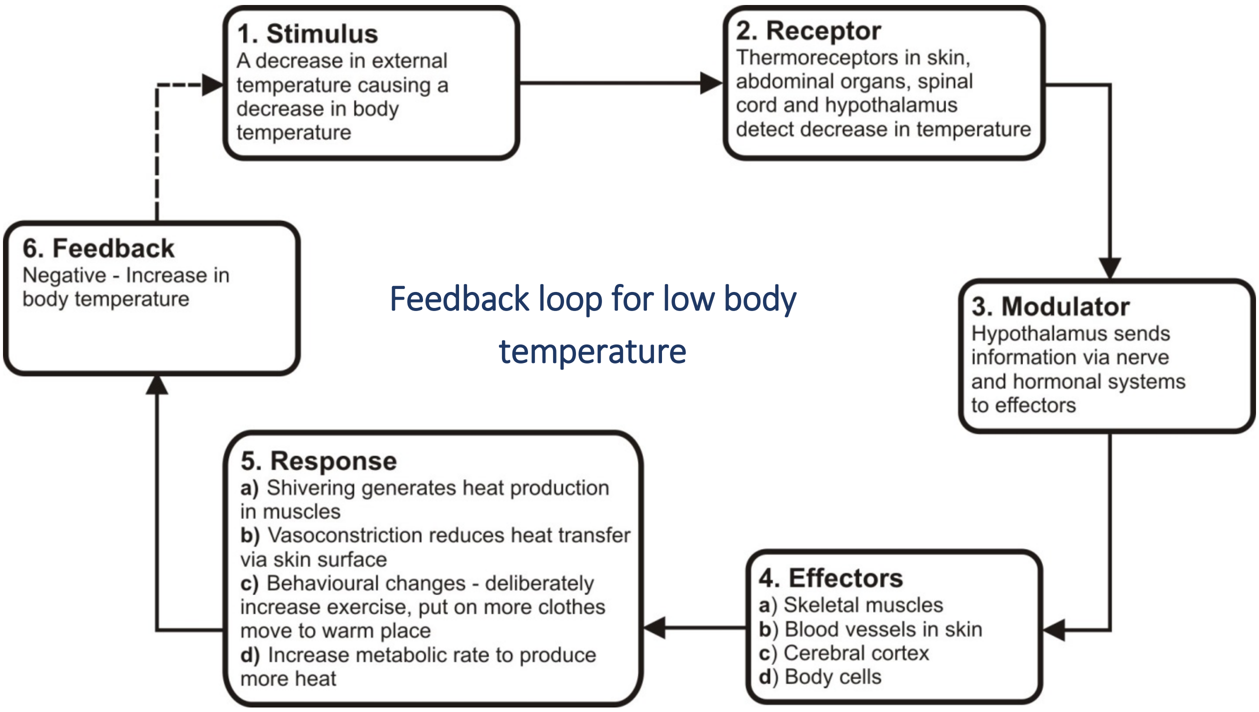
Humans can respond in two ways:

1. **behavioural** - where we consciously change our behaviour
2. **physiological** - where our body automatically alters its functioning without conscious control.

Raising body temperature

Think about the last time you felt cold. What sorts of things did you do that made you feel warmer? The body responds physiologically and behaviourally to a drop in the external temperature.

The following diagram is the feedback model. Study the diagram to discover the series of events that helps the body deal with a drop in temperature.



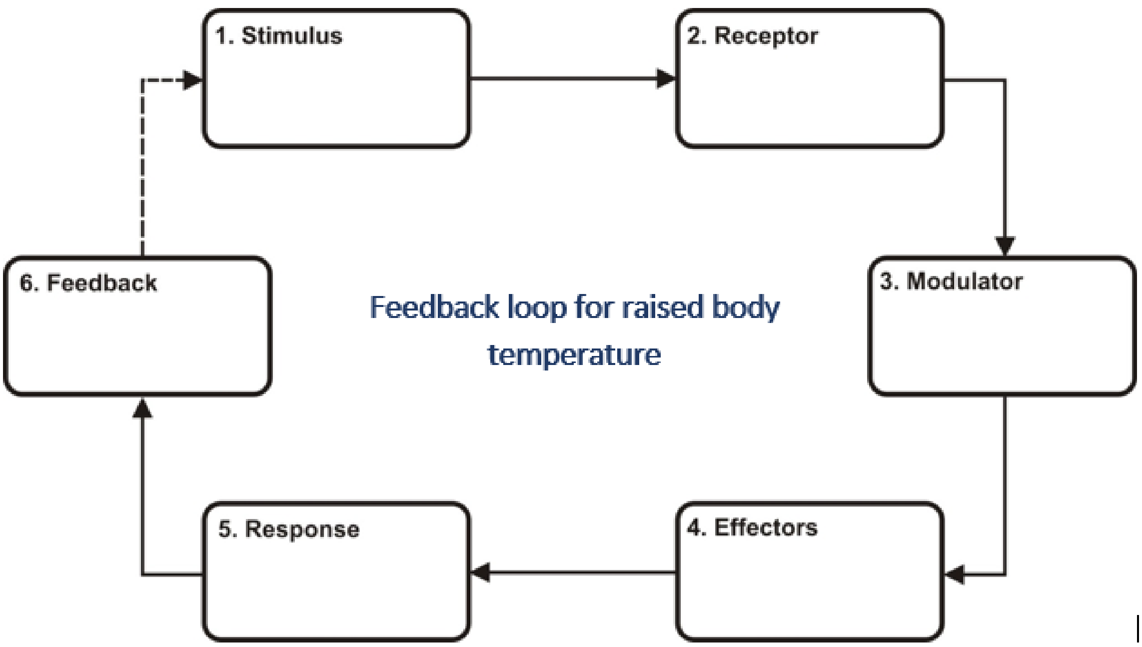
This is a **negative feedback** loop that illustrates the steps involved when the stimulus of a decrease in external temperature causes a decrease in body temperature. This information is detected by thermoreceptors located in the hypothalamus, skin, abdomen and spinal cord. The modulator, the hypothalamus, sends information via nerve and hormonal systems to effectors which are the skeletal muscles, blood vessels in the skin, cerebral cortex and body cells. The responses created include shivering which generates heat production in the muscles, vasoconstriction which reduces heat transfer via the skin surface, behavioural changes which involve deliberately increasing exercise, putting on more clothes and moving to a warmer place and lastly increasing metabolic rate to produce more heat. This response reverses the original stimulus and the internal body temperature begins to increase.

Activity

Increase in external temperature

Match the steps in the first column with the correct explanation in the second column. Then, use the information to complete the feedback model below that summarises how the body responds to an increase in external temperature.

Steps:	Choose from the following:
1. Stimulus	a. Sweat glands, blood vessels in skin, cerebral cortex, body cells
2. Receptor	b. An increase in external temperature causes an increase in body temperature
3. Modulator	c. Thermoreceptors in skin, abdominal organs, spinal cord and hypothalamus detect increase in temperature
4. Effectors	d. i) Increase in sweat gland secretion will increase evaporation. ii) Vasodilation – skin blood vessels will release heat to environment. iii) Behaviour changes to deliberately increase heat loss, seek cool places, remove clothing. iv) Decrease in Metabolic rate will reduce heat production.
	e. Hypothalamus send information via nerve and hormonal systems to effectors
	f. Decrease in body temperature



Regulation of Body Fluids

The body relies upon a constant fluid level to ensure metabolic reactions within cells can proceed. Gases, nutrients, ions, hormones and wastes are carried in body fluids.

Activity

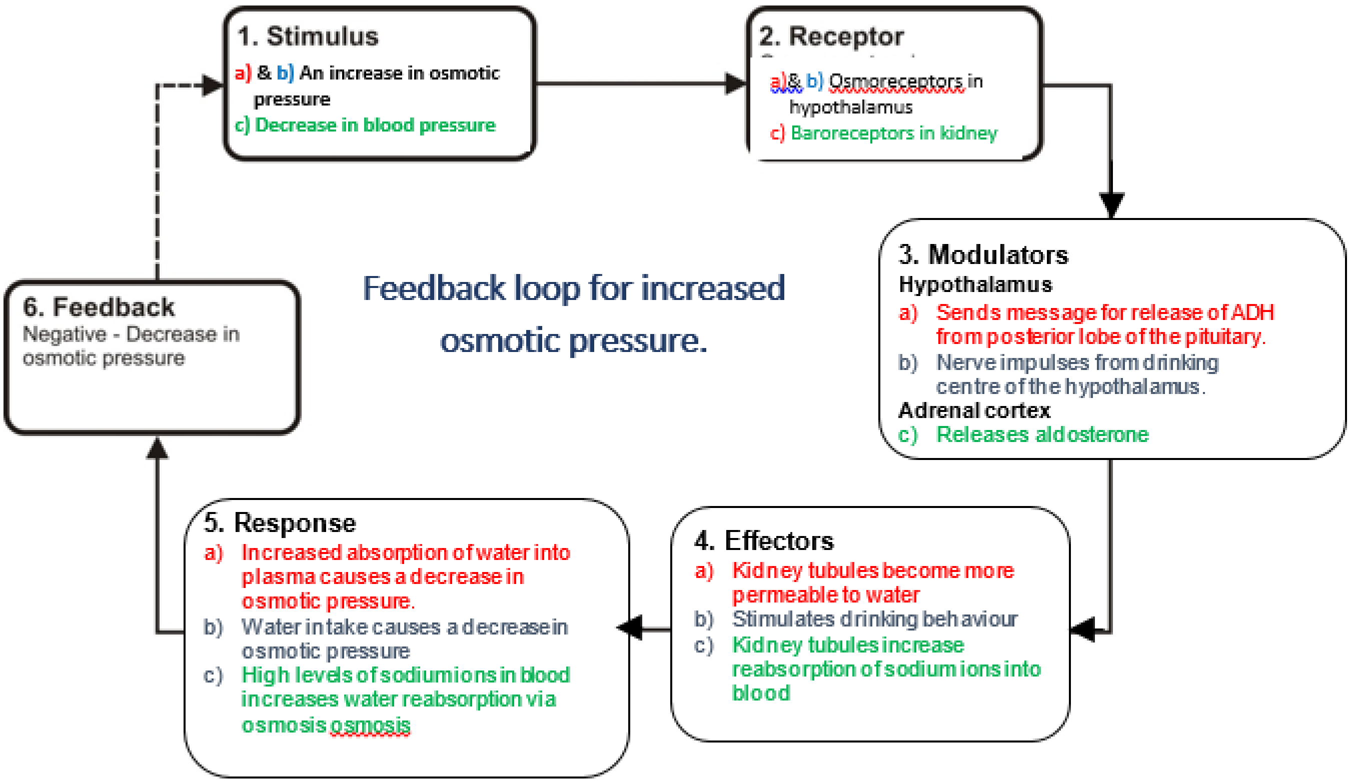
To learn more about how the body regulates its fluid composition, use a text book or other reference material to help you answer the questions below.

1. What different types of fluid components make up the body?
2. What are the main constituents of the body's fluids?
3. How are body fluids gained and lost from the body?
4. Define:
    - intracellular fluid
    - extracellular fluid
    - plasma
    - interstitial/intercellular/tissue fluid.
5. There is a constant exchange of materials between the plasma, intercellular and intracellular fluids. How does the size of the molecules affect movement between these fluids?
6. Describe the movement of small molecules between these fluids.
7. What system of vessels exists in the body that assists in draining excess fluid from the cells and tissues?

Osmotic pressure

Water is continually being lost from the body in a variety of ways, for example through sweat and urine. When water is lost from any of the body fluids, dissolved solutes become more concentrated and water is less concentrated - this creates **high osmotic pressure**. When water content increases and solutes are less concentrated this creates **low osmotic pressure**. Changes in osmotic pressure will stimulate responses in the body to ensure water levels are maintained in optimum amounts.

The following diagram is the feedback model for increased osmotic pressure, for example after exercising.



Note: the different colours and letters (a, b, c) above link modulators to their relevant effectors and responses.

Explaining the feedback loop:

The stimulus is an increase in osmotic pressure (water concentration in plasma decreases) due to exercising. This is detected by osmoreceptors in the hypothalamus. The modulator, the hypothalamus, sends a message to release ADH from the posterior lobe of the pituitary gland and nerve impulses from the drinking centre. The effectors are the kidney tubules becoming more permeable to water and the stimulation of drinking behaviour. The responses that occur are an increased reabsorption of water into plasma and an increase in water intake causing a decrease in osmotic pressure which reverses the original stimulus.

Aldosterone

Aldosterone belongs to a class of hormones called corticosteroids, produced by the adrenal cortex. The hormone acts mainly in the functional unit of the kidneys, the nephron. It aids in the reabsorption of sodium, excretion of potassium and causes water retention to stabilize blood pressure. Overall, the hormone helps to increase the reabsorption of water and sodium ions in the kidneys to maintain sufficient blood volume levels, stabilizing the blood pressure. There is a diurnal (twice daily) secretion of aldosterone at 8am and midnight.

Note:

- If you are dehydrated more water is lost than sodium so the osmolarity (concentration) of body fluids increases. The body must conserve water but not sodium. So ADH is secreted.
- If you lose a large amount of blood from trauma or surgery the loss of sodium and water are proportional. So the body must conserve water and sodium. So ADH and aldosterone are secreted.

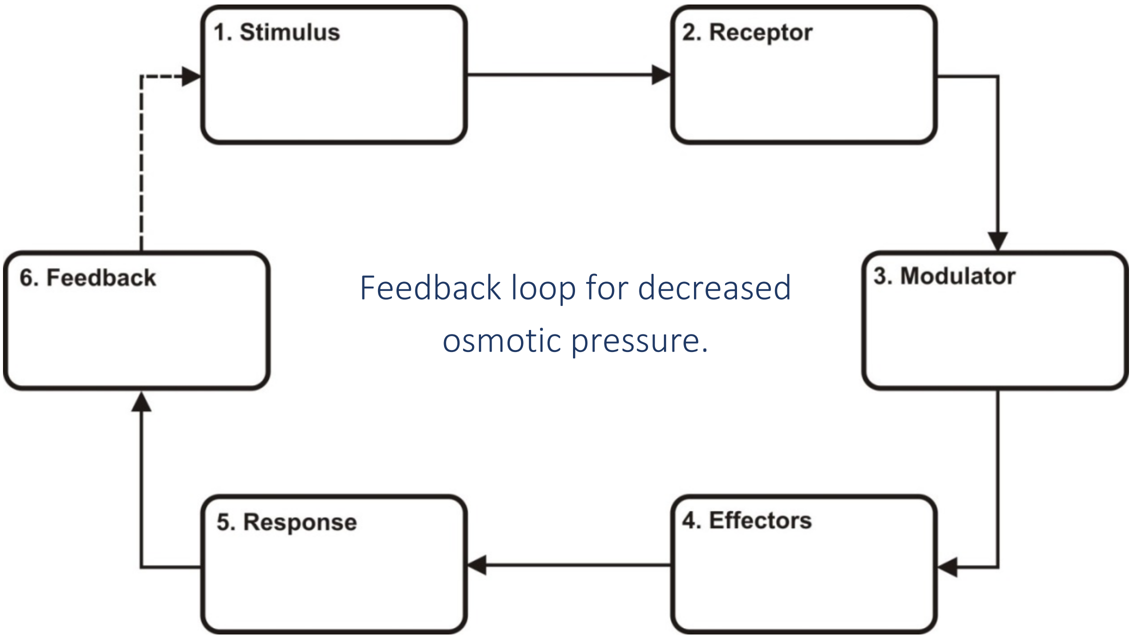
Decreased osmotic pressure

Activity

Use the above feedback loop to assist you to complete a loop for the decrease in osmotic pressure.

Hint: *Much of the content of the new loop will be the same as the ADH example- only the actions will be reversed. Also nothing should be written about the drinking centre and its effects as it is not activated in this case.*

Write the answers in the spaces to complete the diagram (see next page). This diagram shows what happens when there is a decreased osmotic pressure in the body, for example a large volume of water is taken in.



Blood Glucose Regulation

What is glucose?

Glucose is a simple sugar or monosaccharide - the building block of carbohydrates. When it combines with oxygen in cells, it produces energy. Without it none of our metabolic reactions could proceed.

Why do we need to regulate it?

Certain tissues like the brain and retina are very sensitive to changes in glucose levels. An excess or deficit of blood glucose for more than a few hours can result in the loss of consciousness and brain damage.

Two important organs that assist in the control of blood glucose regulation are the pancreas and the adrenal gland. The pancreas contains specialised cells, the Islets of Langerhans, which respond to the ever changing levels of blood glucose. The adrenal gland also plays a role in times of low blood glucose levels.

The pancreas

The pancreas is a large mass of glandular tissue lying between the stomach and the small intestine. Much of the pancreas consists of exocrine tissue which secretes digestive enzymes into the small intestine. The pancreas also contains endocrine tissue that secretes hormones into the bloodstream. Scattered throughout the pancreas are small masses of endocrine tissue called the Islets of Langerhans.

The Islets of Langerhans

The important cells within these clusters are the alpha and beta cells.

Alpha cells detect low blood glucose and respond by secreting the hormone glucagon. The target cells for glucagon are in the liver and the body's cells. Liver cells respond by breaking down glycogen to glucose (**glycogenolysis**) and releasing it into the bloodstream where it is transported around the body to where it is required. A process called **gluconeogenesis** also takes place in the liver and this makes new glucose molecules from molecules other than carbohydrates, for use in the body. **Lipolysis** is a process that also contributes to increasing the blood glucose level. It involves the breakdown of fat (adipose tissue) from body stores into glucose.

Beta cells detect high blood glucose levels and in response, secrete the hormone insulin. Cell membranes respond to insulin by becoming more permeable to glucose and the liver converts glucose to glycogen (**glycogenesis**). In addition, insulin stimulates the conversion of glucose to fat in adipose tissue (**lipogenesis**). It also converts excess glucose into protein through protein synthesis.

The Adrenal Glands

These glands also respond during times of low blood glucose. During exercise the adrenal medulla is stimulated to produce adrenalin. This fast acting hormone behaves in a similar way to glucagon, raising blood glucose levels quickly when required.

The adrenal cortex is stimulated by adrenocorticotrophic hormone (ACTH) during times of low blood sugar. It stimulates the release of cortisol, which promotes the mobilisation of fatty acids to provide energy for working muscles, rather than using glucose.

Activity

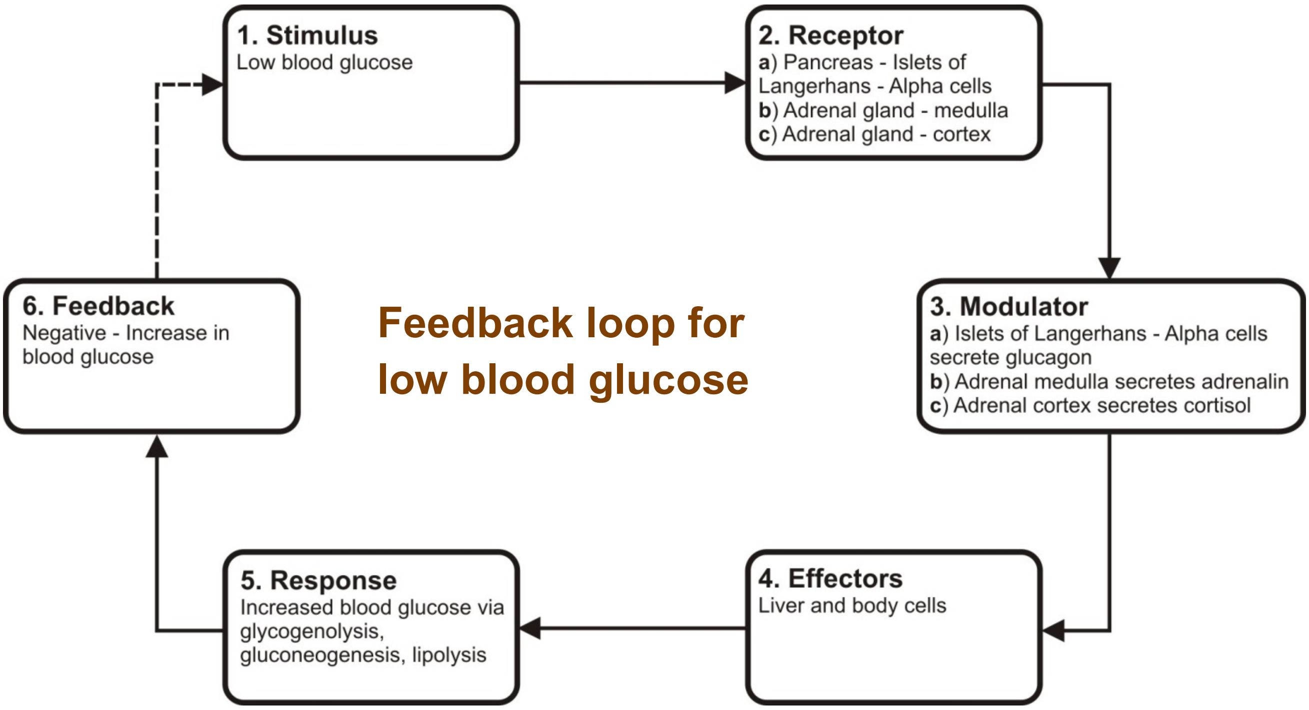
The many processes involved in the regulation of blood glucose can become confusing. This activity will help reinforce the differences between each one.

Provide the correct term for each definition		
	Term	**Definition**
1.		The making of new glucose molecules from substances such as proteins and lipids
2.		Formation of glycogen from carbohydrates, mainly glucose
3.		The conversion of glucose to fat
4.		The breakdown of glycogen to glucose
5.		The breakdown of fat into glucose

Regulation of blood glucose feedback model

Follow the sequence of the feedback model to reveal the steps that occur in response to a low blood glucose level.

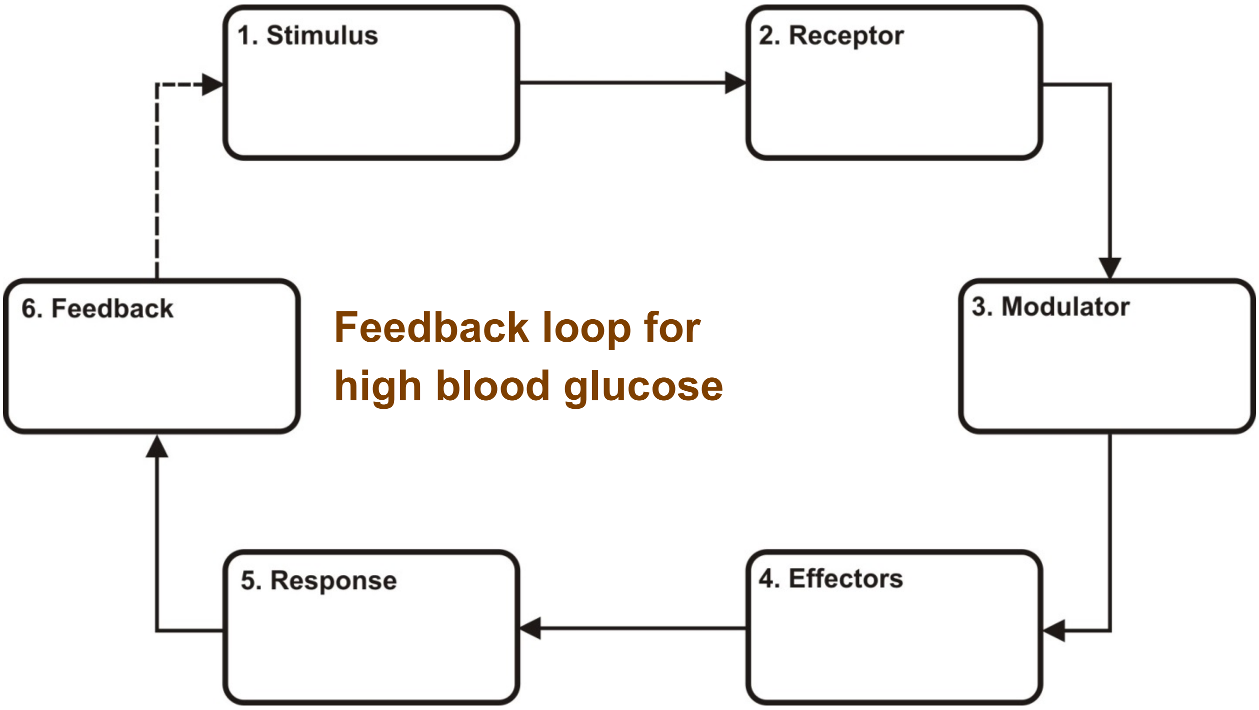
Low blood glucose



High blood glucose

Activity

Now, using statements a-f below, complete the feedback loop, but this time, the stimulus is brought on by eating a meal.



Statements to use in the feedback loop:

a. i) Liver, skeletal muscle cells
   ii) Body cells
   iii) Adipose tissue

b. Islets of Langerhans – beta cells secrete insulin

c. i) Decreased blood glucose via glycogenesis
   ii) Increased transport of glucose into cells and increased cellular metabolism.
   iii) Lipogenesis

d. High blood glucose

e. Islets of Langerhans – beta cells

f. Decrease in blood glucose

Regulation of Gas Concentrations

Every cell in the body requires oxygen for respiration so that sufficient energy can be produced. Carbon dioxide, a waste product, is also produced and needs to be removed. Therefore, the levels of both gases must be regulated. This is achieved by a homeostatic mechanism that controls breathing. Unlike other homeostatic mechanisms, we have some voluntary control over this process.

Control of breathing

The intercostal muscles (between the ribs), the lungs and the diaphragm (a sheet of muscle) work together to move air into and out of the lungs. Nerve impulses control the muscles and these are sent from the respiratory centre, which is located in the medulla oblongata at the base of the brain.

Activity

What structures are involved?

The major structures that assist in the breathing process are intercostal muscles, lungs, rib cage and diaphragm.

Label these structures on the X-Ray image below.

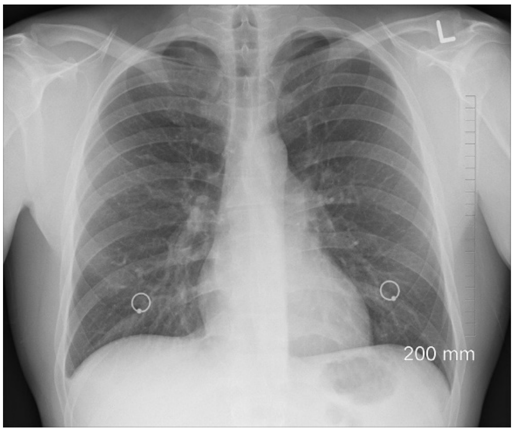


Image by oracast from Pixabay

Lung

Rib

Intercostal muscle

Diaphragm

The respiratory centre is comprised of two regions: the inspiratory centre that controls inspiration and the expiratory centre that controls expiration. Messages are sent between these two centres to regulate the breathing process.

Homeostasis and breathing rate

Oxygen, carbon dioxide and hydrogen ions are carried in the blood and their concentrations all have an effect on your breathing rate. Two key structures involved in the homeostatic mechanism of breathing rate are the respiratory centre (located within the medulla located at the base of the brain) and the carbon dioxide receptors located in the aorta of the heart.

Hydrogen ions

When carbon dioxide dissolves in water it forms carbonic acid (H_2CO_3) which then breaks down to form hydrogen ions (H^+) and bicarbonate ions (HCO_3^-). Increased H^+ will cause a decrease in blood **pH** and this causes an increase in breathing rate.

Carbon dioxide

A slight increase in carbon dioxide concentration leads to a **marked** increase in breathing rate. As mentioned above, an increase in H^+ leads to an increased rate of breathing. Together CO_2 and H^+ stimulate receptors located in the respiratory centre (of the medulla oblongata) and in major arteries - the carotid and the aorta. Receptors that are stimulated by chemicals like CO_2 or H^+ are called **chemoreceptors**.

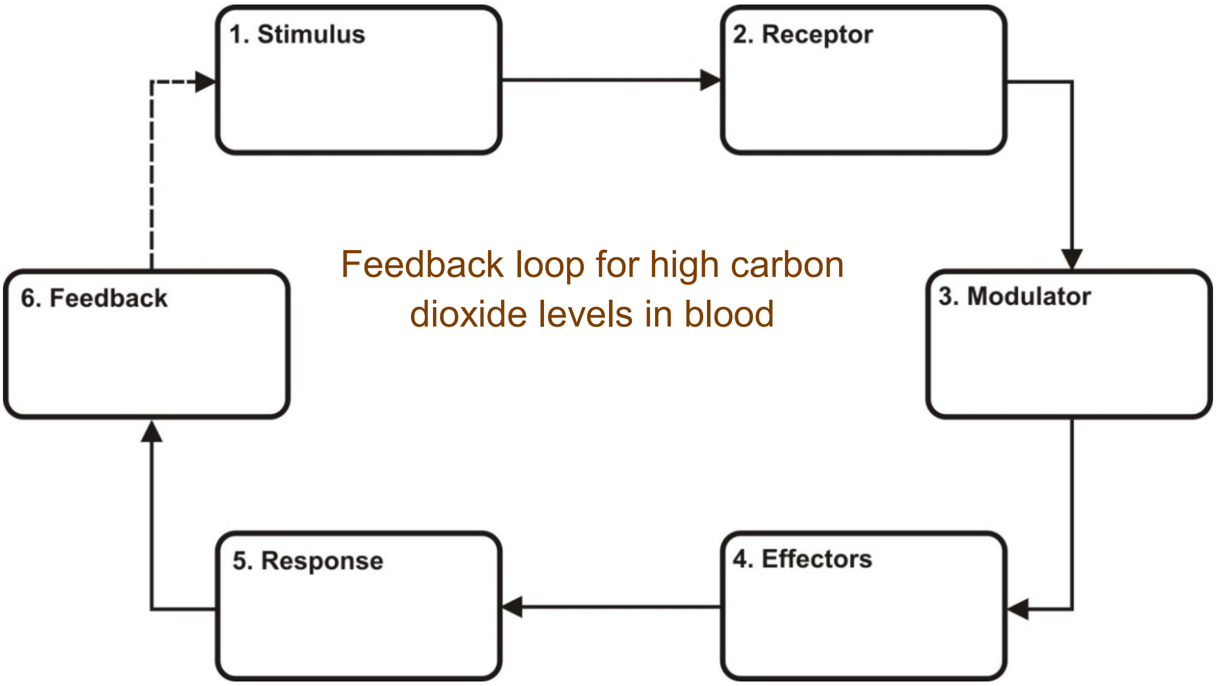
Oxygen

As oxygen is being continually used by cells, so its concentration in the blood decreases. In contrast to carbon dioxide, oxygen concentration needs to **fall significantly** before any increase in breathing rate results. Chemoreceptors that detect oxygen concentrations are located in the walls of two major arteries, the carotid and the aorta. These cells are known as the aortic and carotid bodies. When these cells detect a decrease in concentration, **nerve impulses** are sent via sensory neurons (of the autonomic nervous system) to the respiratory centre. From here, impulses are sent by motor neurons (of the somatic nervous system) to the respiratory muscles to stimulate the breathing process.

Activity

Control of breathing

Use the information on the previous page to complete a stimulus-response feedback loop for control of breathing. Remember the concentration of carbon dioxide is the main stimulus for breathing.



Statements to use to complete the feedback loop:

a. Respiratory centre in medulla oblongata of the brain

b. Increased CO_2, increased H^+

c. Increased stimulation of respiratory muscles by the autonomic nervous system causes increased breathing rate and depth to reduce CO_2 and H^+ levels

d. Chemoreceptors in respiratory centre and in carotid arteries and aorta

e. Diaphragm, intercostal muscles

f. Decrease in CO_2, decrease in H^+

Voluntary Control of Breathing Rate

Without the ability to voluntarily control our breathing, vocalising activities like speaking and singing would be impossible. Voluntary control comes via the cerebral cortex and bypasses the respiratory centre in the medulla oblongata. Being able to voluntarily hold one's breath can be a protective mechanism to prevent poisonous gases or water from entering the lungs. However, we can only hold our breath for a limited time. Once the carbon dioxide levels build up, the inspiratory centre will be stimulated and we will be forced to take a breath whether we want to or not.

Activity

Feedback loops

Look back at each of the feedback loops covered in this topic and answer the following questions:

1. Which loops are controlled by the endocrine system?
2. Which loops are controlled by the nervous system?
3. Are any of the loops controlled by the endocrine and nervous system?

This has been quite a complex topic so far. A good revision exercise would be to go to 'Connecting Concepts: Interactive lessons in Biology' http://ats.doit.wisc.edu/biology/ap/ho/ho.htm *and work through the three lessons on homeostasis.*

When things go wrong! – Disruption to Homeostasis

As humans interact daily with the external environment, homeostasis keeps the body's cells and tissues functioning steadily. Sometimes the body's mechanisms are interrupted by events including hormonal dysfunction and disease. Our lifestyle choices and behaviours also play a significant role in disrupting our internal balance.

You will now learn how medical intervention can be used to treat disruption to homeostatic mechanisms and explore some of the risks and benefits that are associated with such treatments.

Hormonal factors causing homeostatic disruption

Endocrine glands secrete hormones which act as chemical messenger molecules. If their secretion is interrupted by malfunctioning glands, the effects can impact on more than just one part of the body. Many conditions exist that are the result of under-secretion or over-secretion of hormones. Unlike the invasion of pathogens like bacteria or viruses (that result mostly in short-term illnesses), the result of hormones being under or over produced can manifest itself in a range of symptoms known as a 'syndrome' or 'disorder'.
Among the glands most commonly experiencing dysfunction are the pancreas and thyroid.

The diabetes dilemma

When the beta cells of the pancreas malfunction, a condition known as diabetes results. **Diabetes mellitus type 1** (juvenile onset) and **diabetes mellitus type 2** (mature onset) are fast becoming significant health issues for many countries - Australia included. Whilst they are incurable conditions, type 2 can be prevented and managed by lifestyle and diet. Below are some statistics about this condition.
More than three million Australians have diabetes or pre-diabetes. Worldwide, 246 million people have diabetes.

- Diabetes is the sixth highest cause of death by disease in Australia.
- People with diabetes are almost three times more likely to have high blood pressure, obesity or elevated blood fats, eg cholesterol and triglycerides.
- They are two times more likely to have cardiovascular disease, eg heart disease and stroke.
- One in four Australian adults has either diabetes or impaired glucose metabolism.

Source: Diabetes Australia-NSW 2009, *Diabetes Facts,* Diabetes Australia-NSW, viewed 10 August 2009, <www.diabetesnsw.com.au/about_diabetes/factsheet.asp>.

So now let's look at understanding this condition better.

Maintaining sufficient levels of glucose is critical for the body to carry out one of the most fundamental energy-producing reactions - cellular respiration. Millions of people around the world suffer from a disruption to this vital process, which, if not treated, can lead to premature death due to complications. Diabetes type 1 results from a disruption in the functioning of the beta cells in the pancreas. It is an **autoimmune condition** whereby the body's own immune system destroys the beta cells and insulin production decreases. Type 2 diabetes is often linked to lifestyle and diet. It results in the body cells becoming desensitied to insulin and glucose uptake and use is therefore impaired.

Activity

Complete the following true/false quiz. For more information, visit: www.diabeteswa.com.au.

	Question	True/False
1.	In diabetes type 2 the pancreas is unable to produce any insulin	
2.	The form of diabetes that usually develops in people over 40 is type 2.	
3.	The pancreas cannot produce sufficient amounts of insulin in types 2 diabetes.	
4.	Target cells lose their responsiveness to insulin in type 2 diabetes	
5.	Type 1 diabetes is referred to as an autoimmune disease	
6.	Type 1 diabetes is the form of diabetes that often develops slowly and can be misdiagnosed	
7.	Obesity is classified as a risk factor for developing diabetes	
8.	Gestational diabetes develops during pregnancy and continues after the birth of the child	
9.	It is possible to take insulin by mouth in tablet form	
10.	Juvenile diabetes is another name for type 1	

Glands behaving badly - The thyroid

Hypothyroidism (Hashimoto's disease) – under secretion of thyroxine due to an autoimmune condition. Symptoms include:

- feeling tired
- eyelids drooping
- face puffy
- voice raspy
- skin dry.

Hyperthyroidism – over secretion of thyroxine. Symptoms include:

- Heart palpitations
- Weight loss
- Increased appetite
- Hand tremors.

Hormonal conditions - What goes wrong and how to fix them

Activity

Complete the summary table that will help you revise the factors that cause these conditions. Fill in the table with suggested words in the box beneath the table.

Mechanisms that go wrong

Choose from the list below and fill in the spaces in the table on the following page.

• blood glucose regulation	• blood vessels	• thyroid gland	• glucose
• glucose	• over-secretion	• heart	• weight loss
• thyroid gland	• under-secretion	• insulin	• weight gain
• thyroxine	• metabolic rate	• thyroxine	• eyes
• metabolic rate	• beta cells in pancreas	• respiration	• kidneys

Disruption condition	Cause	Homeostatic mechanism involved	Which parts of feedback model are affected? (Eg: receptor/ modulator/effectors)	Impact in body	Symptoms
Diabetes type I	beta cells not producing enough insulin or none at all	______________ ______________	receptor, modulator – __________________	lack of ______________ results in ______________ not taken up by cells/liver/muscles insufficient ______________ in cells for ______________ to proceed glucose remains in circulating blood	**Short-term** tiredness, hunger, increase in osmotic pressure leads to thirst. **Long-term** damage to the large blood vessels of the ___________, brain and legs damage to the small ___________, causing damage to the ___________, ___________, feet and nerves – can lead to blindness, kidney failure, amputation of limbs
Diabetes type 2		______________ ______________	effector – __________________		
Hyperthyroidism	______________ of thyroxine	______________ ______________	effectors – __________________	elevated levels of ________________ causes metabolic rate to rise	______________________________ increased heart rate palpitations nervousness trembling hands insomnia
Hypothyroidism	______________ of thyroxine	______________ ______________	effectors – __________________	decreased levels of ________________ causes reduced metabolic rate	________________________ tiredness dry skin intolerance to cold slow heart rate

Treatments for hormonal conditions

Using the internet to help you, summarise the treatments available for the conditions in the next worksheet.

Complete a summary of what is currently used to treat each of the conditions listed.

	Treatments for hormonal condition
Diabetes	Type 1: Type 2:
Hypothyroidism	
Hyperthyroidism	

Textbook References and Study Guide Questions

The following sections of the texts listed below will help you to consolidate your understanding on the content covered in this booklet.

- Read Nelson *Human Perspectives ATAR Units 3 and 4* textbook Chapters 7,8 and 9. Complete the Review Questions and Apply your knowledge questions on pages 100,101, 106 and 127
- Work through *Academic Associates WACE Study Guide Human Biology Y12 ATAR* course Chapter 4 and Trial Test 4

PAST EXAM QUESTIONS

Complete questions 32, 35 and 38 taken from the 2018 ATAR Human Biology examination paper

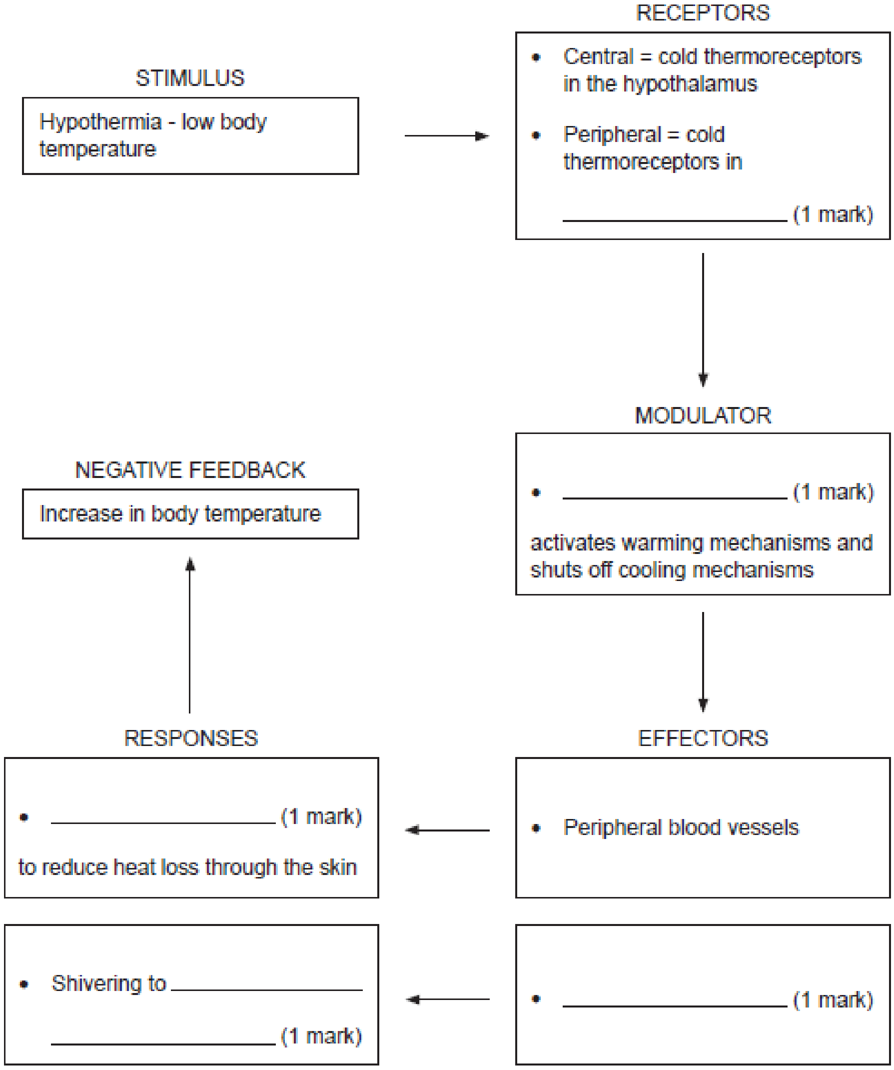
Source: School Curriculum and Standards Authority, Human Biology 2018 ATAR Examination
https://senior-secondary.scsa.wa.edu.au/further-resources/past-atar-course-exams/human-biology-past-atar-course-exams

Question 32 **(11 marks)**

Jai was snowboarding in Japan when he was caught in an avalanche. He was partially buried in the snow and it took several hours to find him. Luckily he was relatively unhurt but, when found, was suffering from the early stages of hypothermia.

Below is a negative feedback model showing the physiological responses to hypothermia.

(a) Complete the feedback loop below by writing the appropriate word/s in the spaces provided. (5 marks)



(b) The people who found Jai in the snow gave him first aid. Identify two behavioural strategies the first aiders could have employed to help his body recover from hypothermia. (2 marks)

____

____

____

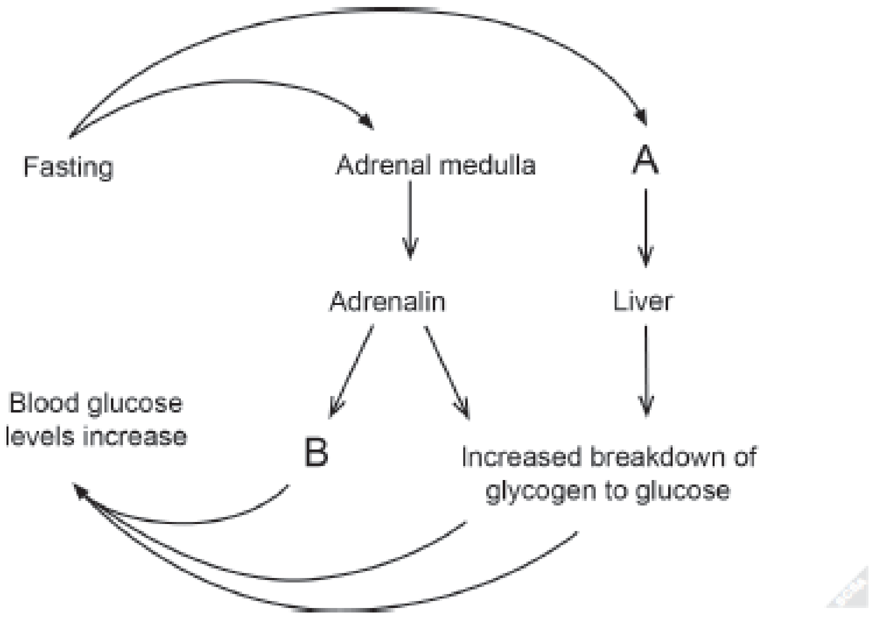
____

(part (c) was not relevant to the section on homeostasis)

Question 35 **(12 marks)**

Before any medical operation involving anaesthetics, individuals are asked to fast (not eat or drink) from at least midnight on the evening before the operation.

The diagram below shows some of the effects of fasting on blood sugar levels.



(a) (i) In the diagram above, what would structure A be? (1 mark)

___

(ii) In this scenario, structure A releases a hormone that acts on the liver. What name is given to this hormone? (1 mark)

___

(iii) Adrenalin acts on many structures to help increase blood sugar levels. What process is occurring at B that would contribute to the raising of blood sugar levels? (1 mark)

___

(iv) What other endocrine gland not shown in the diagram above could possibly be involved in maintaining blood sugar levels? (1 mark)

___

The dawn phenomenon is a normal, natural rise in blood sugar that occurs in the early morning hours, between roughly 4 am and 8 am. The rise in blood sugar is normally handled with hormones and a healthy person will feel no effects. People with diabetes, however, feel the effects of having high sugar levels in their blood.

(b) To help lower blood sugar levels, a series of processes occurs in various effectors. Define each of the following terms and name the structures in which each process occurs. (4 marks)

Process	Definition	Structure/s
Glycogenesis		
Lipogenesis		

(c) Explain why a person with diabetes would feel the effects of high blood sugar, such as tiredness and excessive thirst. (4 marks)

Question 38 **(12 marks)**

An investigation was carried out into the effectiveness of a new asthma bronchodilator, to be used to increase the oxygen concentration in the blood of patients suffering from chronic asthma.

Two groups of patients suffering from chronic asthma were treated: group 1 received the new asthma bronchodilator and group 2 a placebo. The base level of oxygen concentration in the blood of the patients in the two groups was measured daily over a period of two weeks prior to the trial.

All patients in both groups began with a similar blood oxygen concentration of 94%, which was 4% lower than normal blood oxygen concentration. After three weeks of the trial, patients in group 1 had an average oxygen concentration of 98%, while group 2 still had an average blood oxygen concentration of 94%.

(a) Suggest a hypothesis that this experiment was designed to test. (1 mark)

____

____

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(b) Name the independent and dependent variables. (2 marks)

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(c) Why was a placebo used for group 2 participants? (1 mark)

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(d) State **three** variables that would need to be controlled to ensure that the experiment was a fair trial. (3 marks)

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(e) Explain how, under normal conditions, a change in gas concentrations in the blood brings about a response that returns the concentrations to acceptable homeostatic levels. (5 marks)

Complete questions 34 and 36 taken from the 2017 ATAR Human Biology examination paper

Source: School Curriculum and Standards Authority, Human Biology 2017 ATAR Examination
https://senior-secondary.scsa.wa.edu.au/further-resources/past-atar-course-exams/human-biology-past-atar-course-exams

Question 34 **(12 marks)**

(a) An athlete had pH levels in his blood measured immediately before and after a 100 metre sprint. The results showed a decrease in pH from 7.45 to 7.35.

(i) Why did the blood pH levels change? (2 marks)

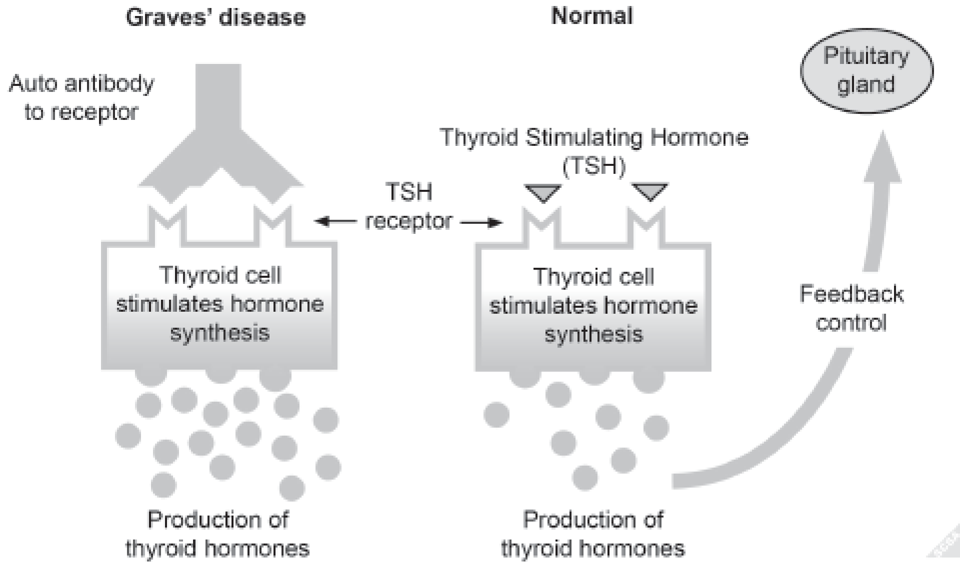
(ii) The decrease in pH was detected by receptors that initiated a response to a change in the rate of breathing.

Describe the events that enabled this change in the breathing rate to occur. (4 marks)

(b) Under normal circumstances, the level of oxygen in the blood does not influence breathing rate. Under what circumstance will oxygen have an effect and what effect will it be? (2 marks)

Question 36 **(11 marks)**

Graves' disease is an autoimmune condition affecting the thyroid gland. The diagram below is a representation of how it alters thyroid function.



(a) According to the information in the diagram, is Graves' disease a type of hypothyroidism or hyperthyroidism? (1 mark)

(b) Identify two symptoms you would expect someone with Graves' disease to display. (2 marks)

(c) Explain how Graves' disease can be treated. (3 marks)

(d) Describe the process that, under normal circumstances, stimulates the release of TSH from the pituitary gland. (5 marks)