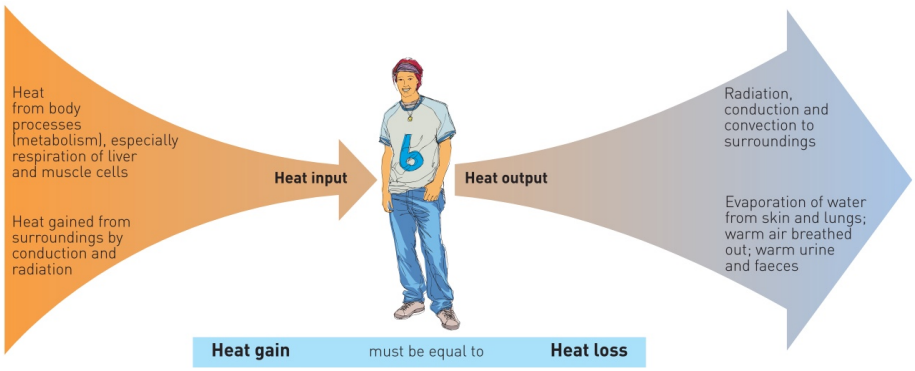
Objective Sheet 3

HOMEOSTASIS **HUMAN PERSPECTIVES CHAPTER 6-9**

1. DESCRIBE HOW THERMOREGULATION IS ACHIEVED BY REGULATING HEAT GAIN OR LOSS FROM THE BODY

Thermoregulation: Maintaining the balance between heat production and heat loss

- The hypothalamus monitors the temperature of the blood and receives impulses from the peripheral thermoreceptors
- Through the negative feedback loop (controlled by the automatic nervous system) it controls the mechanism for maintaining temperature, such as diameter on blood vessels, sweating, shivering, metabolic rate ect.



2. STATE THAT THE NORMAL BODY TEMPERATURE OF HUMAN IS APPROXIMATELY 36.7*C

3. DESCRIBE THE LOCATION OF THE THERMORECPTORS IN THE BODY

Peripheral nervous system - in skin and mucous membranes

There are 2 types of peripheral thermorecptors

- Cold (stimulated by drop in temperatures)
  - When stimulated the hypothalamus receives the information and initiates heat conservation and heat production mechanisms
- Heat (stimulated by a rise in temp)
  - When stimulated the hypothalamus receives the information and stimulates reduction of heat production, and increase in heat loss mechanisms

Central nervous system – in hypothalamus, spinal cord, abdominal cavity (receives info from body core)

4. DESCRIBE HOW HEAT CAN BE TRANSFERRED BY CONDUCTION, CONVECTION AND RADIATION

Conduction: Heat transfer by two objects in direct contact

- Heat flows from hot to cold with physical contact
- Th larger the surface area the larger the heat loss

Convection: Heat exchange by contact with the motion of a moving substance (air or water)

- Heat flows from hot to cold by air or water currents
- The layer of warm air which continually surrounds our body is displaced by cooler air, when the air temperature is lower than skin temperature

Radiation: Transfer of heat via electromagnetic waves
- Heat flows from a hot to cold without physical contact
- Heat loss via radiation occurs when core temperature is higher than room temperatures
- Heat gain via radiation occurs as room temperature is higher than core temperature

5. EXPLAIN HOW THE EVAPORATION OF SWEAT CAN LEAD TO COOLING OF THE BODY

Evaporation is the cooling of the body as a result of the vaporisation of sweat. Where a liquid changes to a vapour or gas.

The thermorecptors in the skin and mucus membrane pick up an increase in temperature and informs the hypothalamus
The hypothalamus causes vasodilation and increase the rate of sweating in order to decrease the temperature
- To avoid over heating the body uses blood to help regulate temperature
- Increased blood flow to the skin results in vasodilation of blood vessels
- Heat is removed from the skin when liquid sweat changes into vapour
- Evaporation of sweat creates a cooling effect
- Cooling of the skin results in cooling of the blood flowing through the skin
- Cooled blood returns to the body and maintains core temperature

Even in the absence of sweating there is continual loss of water by evaporation from external body surfaces. Evaporation occurs in the lungs and respiratory passages aswell as skin

6. DESCRIBE HOW THE BODY RESPONDS TO THE FALL/RISE IN THE BODY TEMPERATURE (BOTH PHYSIOLOGY AND BEHAVIOURAL)

PREVENTING BODY TEMPERATURE FROM FALLING (WHEN EXTERNAL ENVIRONMENT IS TOO COLD)

Physiological changes:
- Vasoconstriction of blood vessels leading to the skin – decreases the flow of warm blood to the skin from internal organs, thus decreasing transfer of heat from internal body organs to the skin. The skin becomes cooler because less warm blood flows through it – therefore less heat will be lost from the body surface.

- Increase in Adrenaline and Noradrenaline – the hypothalamus stimulates adrenal medulla by sympathetic nerves to release these two hormones in the blood. These hormones increase cellular metabolism that leads to an increase in heat production. This helps maintain internal body temperature in conditions where there is rapid heat loss

- Increase In Thyroxine – the hypothalamus is able to cause the anterior lobe of the pituitary gland to secrete thyroid-stimulating hormone (TSH), which causes the thyroid gland to release thyroxine into the blood. This increases the metabolic rate, therefore increase in body temperature. This response is slower to act, but longer lasting.

- Shivering – a fall in body temp will cause the hypothalamus to send stimuli to parts of the brain that increase skeletal muscle tone. This causes the muscles shivering which increases heat production, as the muscles aren't doing work the energy they produce can be used to heat the body

Behavioural response:
- Putting on an extra jumper or sheltering from a cold wind. Another is reducing the surface area of the body.

PREVENTING BODY TEMPERATURE FROM RISING (WHEN EXTERNAL ENVIRONMENT IS TOO HOT)

Physiological responses:

- Vasodilation of blood vessels leading to the skin – increases blood flow through the skin. The skin becomes reddish in colour; surface temperature increases so there is greater heat loss through radiation, convection and evaporation

- Sweating – increase heat loss from the skin. The cooling effect of sweating is only effective if the environment is dry. If the air is very humid, sweat cannot evaporate, because of the saturated air

- Decrease in Thyroxine – in long term, there can be decrease in metabolic rate, which means less heat is produced in the body, therefore decrease in body temperature

Behavioural response:

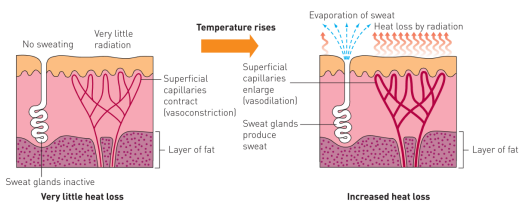
- Turning on a fan, or air conditioner, removing external clothing, reducing physical activity, to help keep temperature constant.

In cold conditions		In hot condition	
To decrease heat loss	**To increase heat loss**	**To increase heat loss**	**To decrease heat production**
- Construction of blood vessels in the skin (vasoconstriction)	- Increase in voluntary activity	- Dilation of blood vessel in skin (vasodilation)	- Decrease in voluntary activity
- Reduction in sweating	- Increased metabolic rate (long term response)	- Sweating	- Decrease metabolic rate (long term adaption)
- Conscious behaviour such as putting on more clothes, sheltering from the wind	- Shivering	- Conscious behaviour such as removing clothing, turning on a fan	
- Reduction of surface area such as by curling up into a ball		- Increase surface area by spreading out	

7. EXPLAIN THE TERMS VASODILATION AND VASOCONSTRICTION

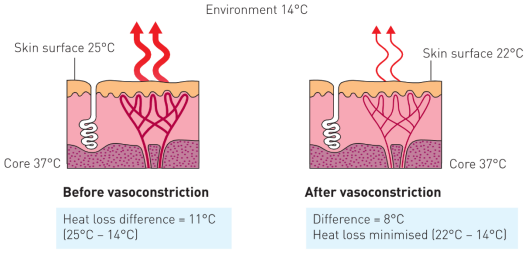
Vasodilation: An increase in the diameter of blood vessels, increasing the flow of blood through them

- The skin becomes reddish in colour, surface temperature rises, and there is greater heat loss through radiation and convection



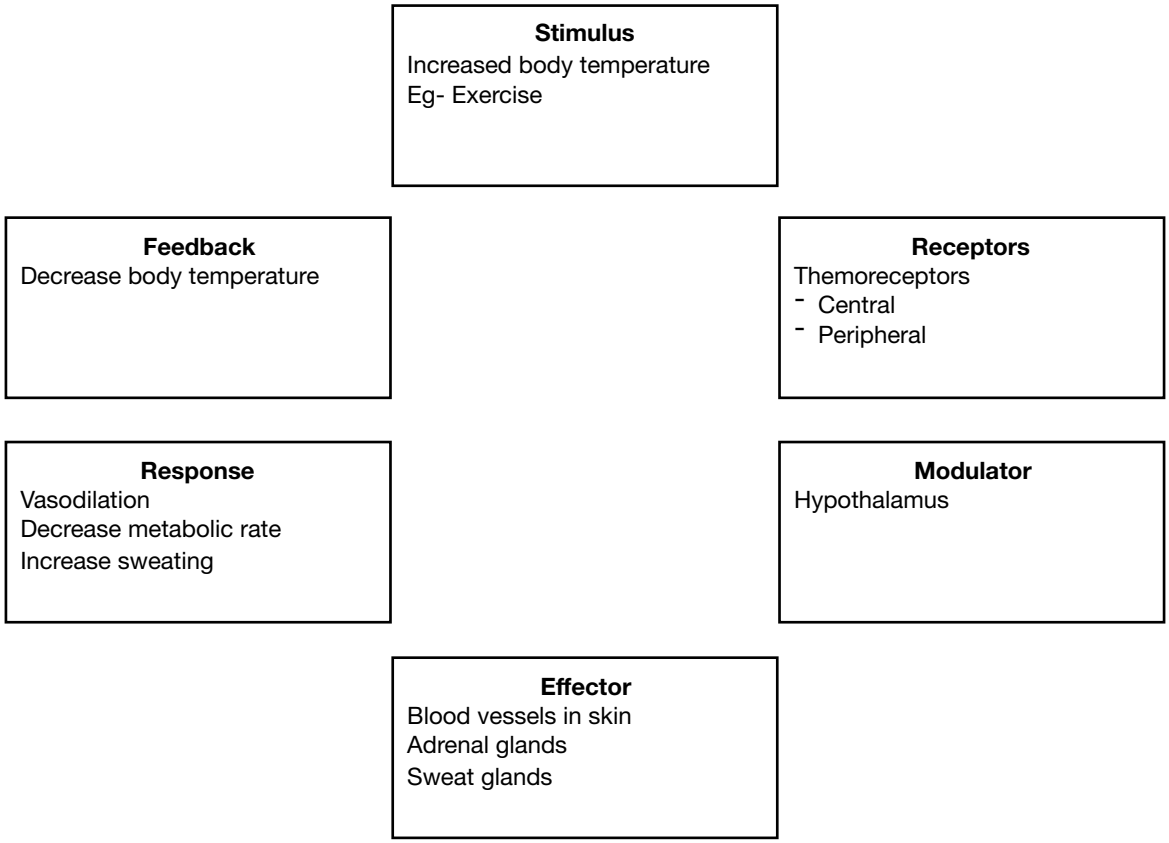
Vasoconstriction: A decrease in the diameter of blood vessels, restricting the flow of blood through them

- The skin becomes colder because there is less warm blood flowing through it. Less heat will then be lost from the body's surface.

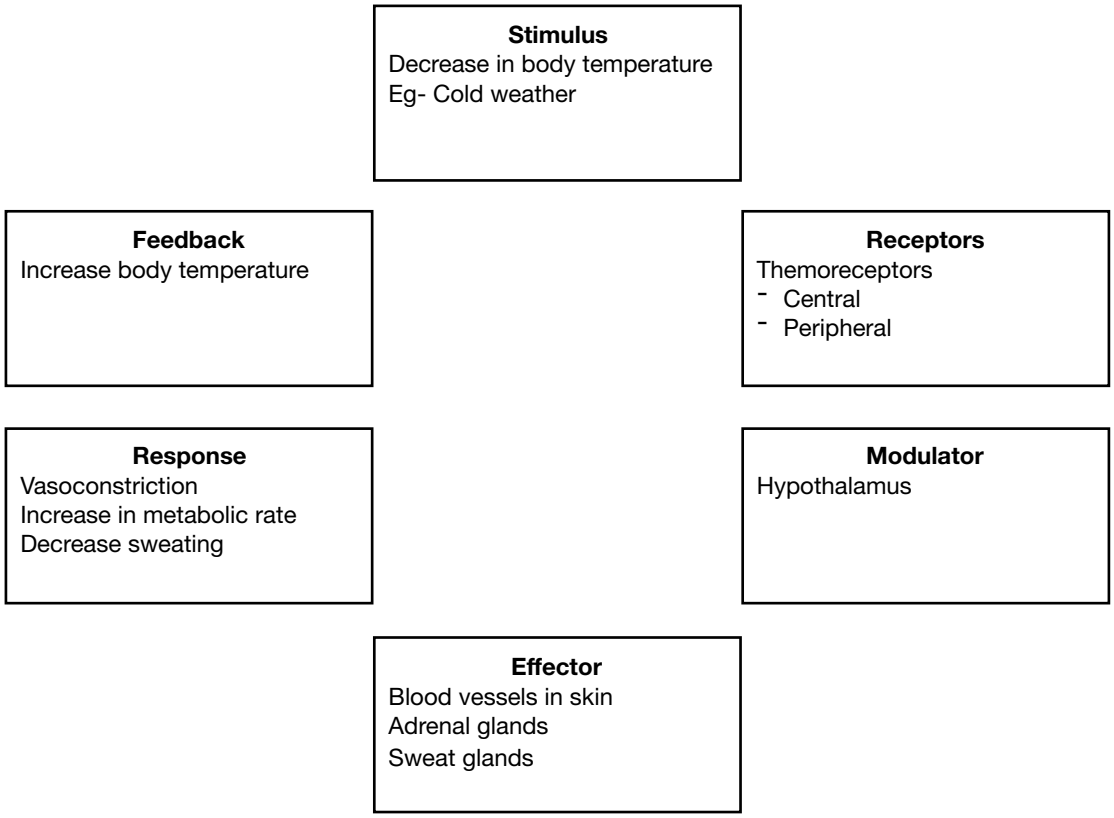


8. DRAW THE FEEDBACK MODEL OF TEMPERATURE CONTROL

HIGH BODY TEMPERATURE



LOW BODY TEMPERATURE



9. WRITE THE WORD EQUATION FOR CELLULAR RESPIRATION

Glucose + Oxygen —> Carbon Dioxide + water + ATP
CHO + O2 -> CO2 + H2O + ATP

10. DESCRIBE THE REGULATION OF CARBON DIOXIDE IN THE BLOOD IN TERMS OF STIMULUS RESPONSE MODEL

INCREASE CO2 AND H+ IN BLOOD

Stimulus
Increased CO2 in blood
Increased in H+ ions
Low pH levels
Eg- Exercise

Feedback
Decrease O2 in blood
Decrease in H+ ions
Increase in pH levels

Receptors
Chemoreceptors
- Medulla
- Aortic bodies
- Cardiac bodies

Response
Increase in rate and depth of breathing

Modulator
Respiratory centre
- Medulla

Effector
Diaphragm
- Phrenic nerve
Intercostal muscle
- Intercostal nerve

DECREASE CO2 AND H+ IN BLOOD

Stimulus
Decrease CO2 in blood
Decrease in H+ ions
High pH levels
Eg- Exercise

Feedback
Increase O2 in blood
Increase in H+ ions
Decrease in pH levels

Receptors
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Response
Decrease in rate and depth of breathing

Modulator
Respiratory centre
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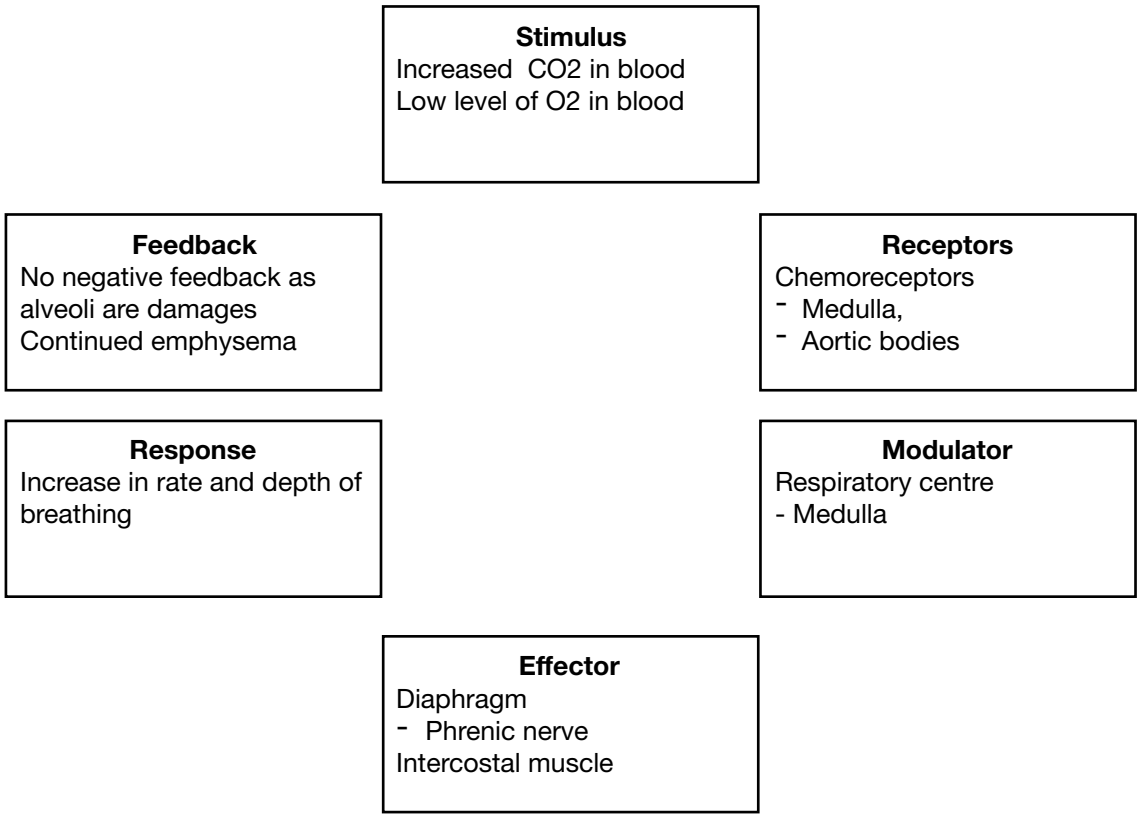
Diaphragm
- Phrenic nerve
Intercostal muscle
- Intercostal nerve

EMPHYSEMA
The Alveoli in the lungs are damaged making the passage of oxygen from the air to the blood more difficult. Thus oxygen level remain low and no negative feedback occurs
Causing the person to gasp for breath in as the response, depth of breathing increases with out the corresponding increase in oxygen



11. DESCRIBE THE RELATIONSHIP THAT EXISTS BETWEEN THE CONCENTRATION OF CO2 IN THE PLASMA AND THE CONCENTRATION OF HYDROGEN IONS

Carbon dioxide + water <—> carbonic acid <—> hydrogen ion + bicarbonate
CO2 + H2O <—> H2CO3 <—>H+ + Hco3-

- Carbon dioxide dissolves in water to produce carbonic acid CO2 + H2O —> H2CO3
- Carbonic acid ionises to form hydrogen ion and bicarbonate ions H2CO3 —> H+ + HCO3
- Thus as carbon dioxide increases so carbonic acid, increasing the concentration of hydrogen ions, decreasing the pH

12. DESCRIBE THE EFFECT ON BREATHING RATE OF AN INCREASE IN HYDROGEN ION CONCENTRATION IN THE BLOOD

- When there is an increase of hydrogen ions there is an increase of breathing rate and depth
- When there is a decrease of hydrogen ions there is a decrease of the breathing rate and depth
- ⬆️ hydrogen = ⬆️ breathing rate and depth
- ⬇️ hydrogen = ⬇️ breathing rate and depth

13. DESCRIBE HOW A VERY LOW CONCENTRATION OF OXYGEN IN THE BLOOD CAN AFFECT THE BREATHING RATE

- Oxygen concentration need to fall to very low levels before there are any major effect of breathing rate
- Large decrease in oxygen concentration simulates the chemoreceptors and the nerve impulse is transmitted to the respiratory centre. These nerve impulses stimulate the transmission if the diaphragm and intercostal muscles, and so the breathing rate increases
- Decrease in oxygen —> increase in carbon dioxide —> increase in breathing rate,
- Regulation of breathing is mainly controlled by carbon dioxide, ph levels and low oxygen concentration (but not as much as CO2 and pH)
- When giving oxygen to a patient it must be given small amounts as high oxygen level removes the stimulus to breath

14. DESCRIBE HOW THE STRETCH RECEPTORS IN THE LUNGS CONTROL INSPIRATION AND EXPIRATION

- Inspiration takes place and lungs inflate
- This is picked up by the stretch receptors in the lungs
- The message is sent from the stretch receptor to the inspiratory neurons in the respiratory centre (medulla)
- Activity of the inspiration neurons inactivated/inhibited and expiration occurs

15. DRAW A STIMULUS RESPONSE FEEDBACK FOR REGULATING OF GAS CONCENTRATION IN THE BODY

Same as outcome 10 refer there for feedback loops

16. UNDERSTAND THE RISKS INVOLVED WITH HYPERVENTILATION

HYPERVENTILATION

- Deep breaths (breathing out CO2 without taking in O2) cause a decrease in CO2 levels in blood.
- No sensation to breathe.
- If underwater, CO2 levels do not reach critical levels.
- Oxygen continues to be used up. Leads to blackout.
- Person loses consciousness, CO2 levels rise.
- Automatically start to breathe.
- Water taken into lungs. Leads to drowning

Anxiety Attacks

- Person starts to breath rapidly. O2 levels lower without a corresponding rise in CO2.
- Low blood CO2 levels can cause blood vessels in brain to constrict, causing dizziness/fainting.

17. DESCRIBE THE REGULATION OF BLOOD SUGAR LEVELS BY THE HORMONES INSULIN, GLUCAGON, ADRENALIN AND CORTISOL IN TERMS OF STIMULUS RESPONSE MODEL

INSULIN
- Produced by the Beta Cells in the Islets of Langerhans in the Pancreas.
- Lowers blood sugar/glucose levels
- By increasing cellular uptake of glucose
- Promoting glycogenesis (Glucose —> glycogen)
- Promoting fat storage

GLUCAGON
- Produced by Alpha cells in the Islets of Langerhans in the Pancreas.
- Raises blood sugar/ glucose levels
- By decreasing cellular uptake of glucose
- Promoting glycogenolysis (glycogen —> glucose)
- Promoting gluconeogenesis (protein and fats —> glucose)

ADRENALINE
- Produced by the adrenal medulla of the adrenal glands.
- Raises blood sugar/glucose levels

CORTISOL
- Produced in the adrenal cortex of the adrenal glands
- Raises Blood sugar/ glucose levels

18. DEFINE THE FOLLOWING TERMS GLYCOGENESIS, GLYCOGENOLYSIS AND GLUCONEOGENIS

GLYCOGENESIS
- The formation of glycogen from glucose.
- It is carried out in the liver
- Reduces blood sugar/ glucose levels
- It is activated by insulin

genesis = the making of

genolysis = the breaking down of

GLYCOGENOLYSIS
- The breakdown of glycogen to form glucose.
- It is carried out by the liver
- Increases blood sugar/ glucose levels
- It is activated by glucagon

GLUCONEOGENESIS
- The formation of glucose from either proteins or lipids
- Is carried out in the liver
- Increases blood sugar/ glucose levels
- Is activated by insulin

19. DESCRIBE BLOOD GLUCOSE CONTROL USING STIMULUS RESPONSE FEEDBACK MODEL

LOW BLOOD SUGAR/GLUCOSE LEVELS

Stimulus
Low blood sugar levels
Eg- Skipping a meal

Feedback
Increase blood sugar levels

Receptors
Chemoreceptors
- Alpha cells
- Islet of langerhans
- Pancreas

Response
Glycogenolysis
Gluconeogenisis
Decrease glucose uptake

Modulator
Pancreas
- Secrete glucagon

Effector
Liver

HIGH BLOOD SUGAR/GLUCOSE LEVELS

Stimulus
High blood sugar levels
Eg- Eating a big meal

Feedback
Decrease blood sugar levels

Receptors
Chemoreceptors
- Beta cells
- Islet of langerhans
- Pancreas

Response
Glycogenesis
Increase glucose uptake

Modulator
Pancreas
- Secrete insulin

Effector
Liver
Somatic cells

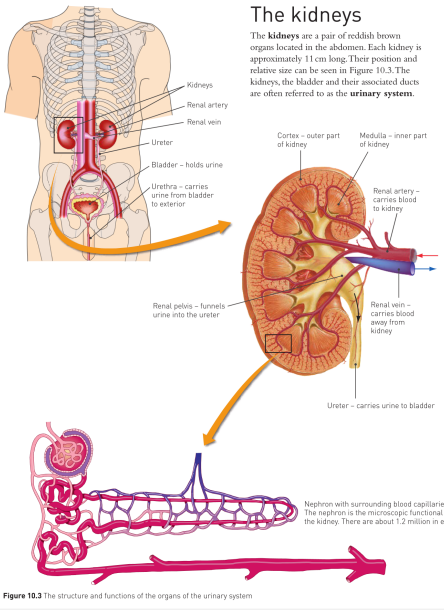
20. EXPLAIN THE IMPORTANCE OF WATER IN BODY FUNCTIONS

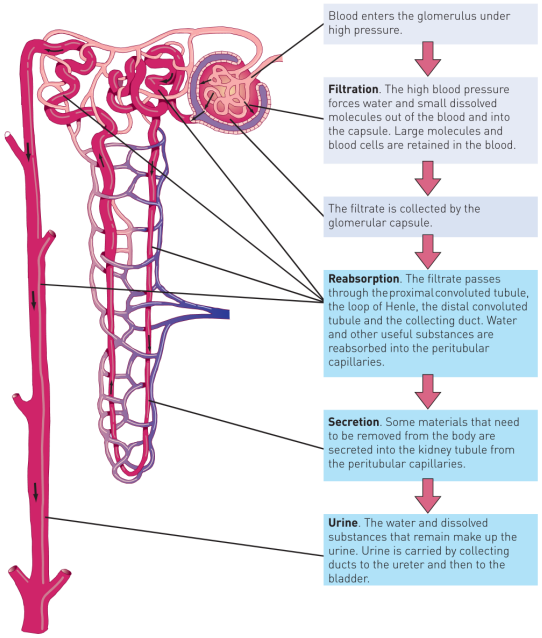
21. DESCRIBE THE TERM OSMOREREGULATION AND HOW IT CAN BE AFFECTED BY INPUTS AND OUTPUTS

Osmoregulation (regulating water)

- Water is continuously loss from the body in the for, of sweat, urine, faeces and exhaled breathe
- Low water concentration —> high osmotic pressure
- High water concentration —> low osmotic pressure
- At times of strenuous activity water loss increase, this more water is lost from the blood meaning a lowering in water concentration and hence a higher osmotic pressure
- Osmoreceptors in the hypothalamus in the thirst centre detect the change in osmotic pressure making the person feel thirsty, thus stimulating the person to drink
- The water is reabsorbed and osmotic pressure returns to normal

22. DRAW AND LABEL THE NEPHRON OF THE KIDNEY, IDENTYING THE LOCATION OF FILTRATION, REABSORPTION AND ACTIVE SECRETION





23. DESCRIBE THE EFFECT OF ADH (ANTI-DIURETIC HORMONE) AND ALDOSTERONE IN MAINTAINING THE WATER BALANCE

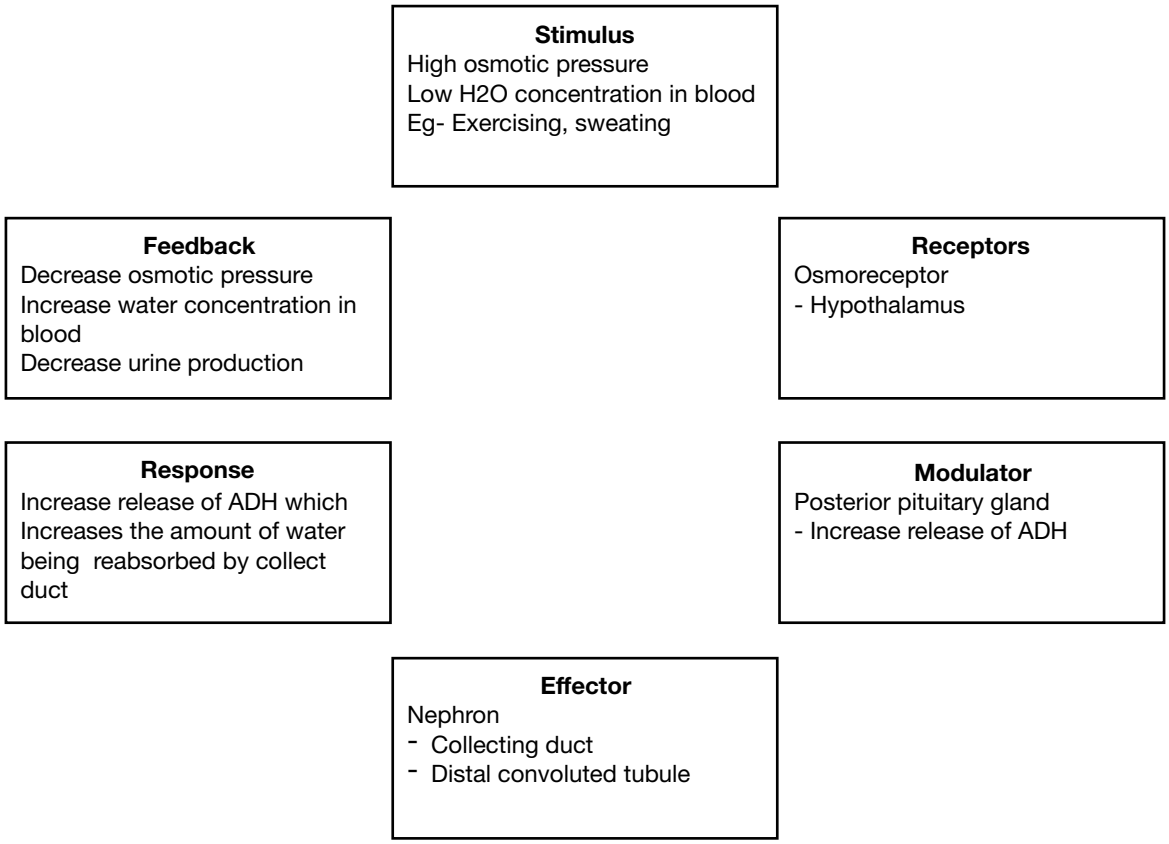
Antidiuretic hormone (ADH)

- Antidiuretic hormone is produced by the hypothalamus and is release in the posterior pituitary
- Aldosterone controls the reabsorption of water
- By controls the permeability of the walls of the distal convoluted tubule and the collecting duct of the nephron (kidneys)
- When the concentration of ADH in the blood is high it increases the permeability of the walls thus water in the nephron is able to be reabsorbed more easily
- This reabsorption of water mean that there is a higher concentration of the material remaining in the nephron, thus the urine is more concentrated. Meaning there is less water in the urine.

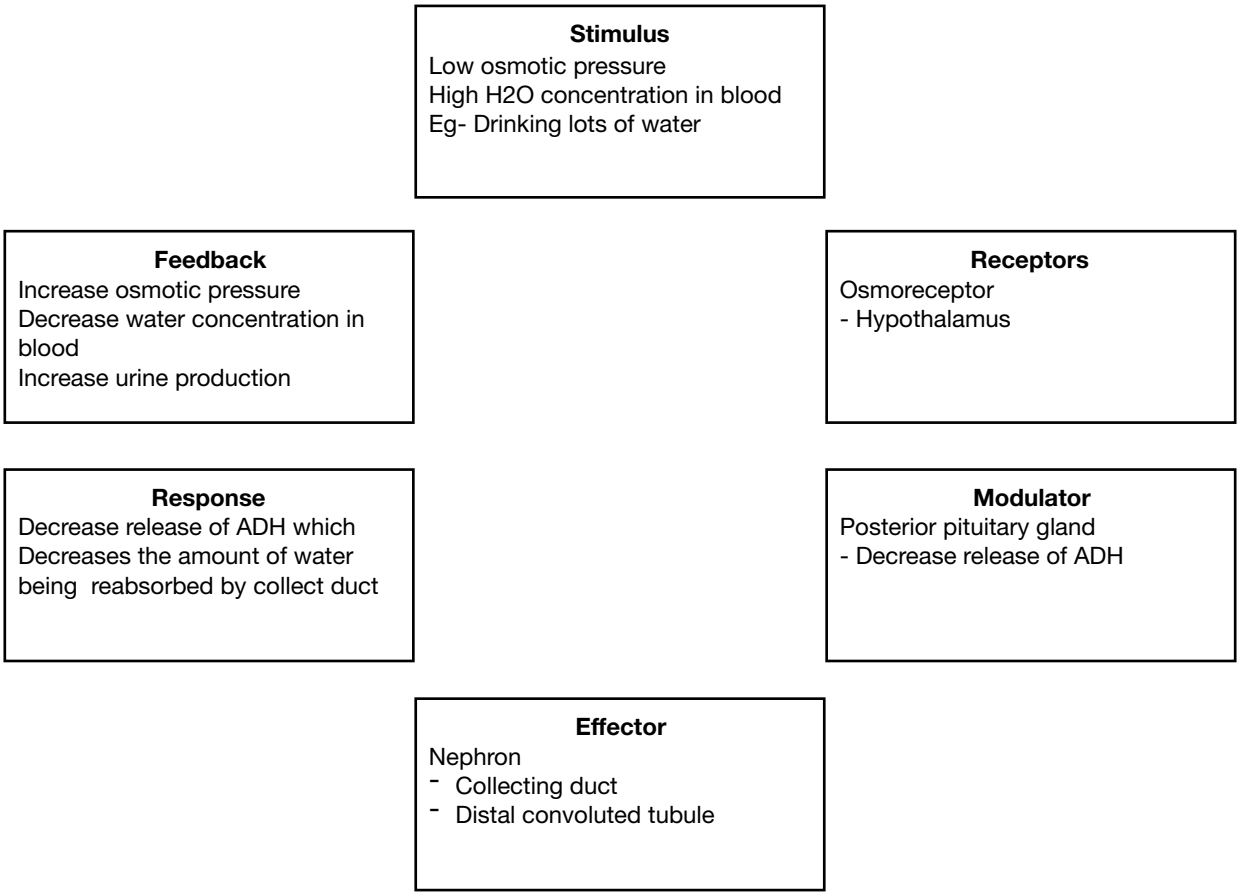
ALDOSTERONE

- Aldosterone hormone is produced by the adrenal cortex
- Aldosterone increases reabsorption of sodium ions and excretions of potassium ion
- Decreasing the concentration of sodium and increase the concentration of potassium in urine

HIGH OSMOTIC PRESSURE / LOW WATER CONCENTRATION

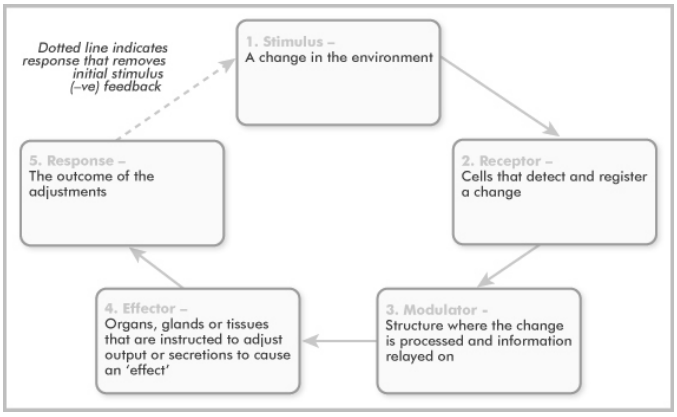


LOW OSMOTIC PRESSURE / HIGH WATER CONCENTRATION



24. DESCRIBE THE COMPONENTS OF A STIMULUS-RESPONSE FEEDBACK MODEL

The stimulus-response feedback model is a simple way of explaining how homeostatic mechanisms work.



1) Stimulus – A change in the environment (of the body) that causes the system to operate
2) Receptor – A sensor that is sensitive to a particular environmental change or stimulus. Is able to detect the stimulus/ change by sensory cells
Message – Sensory cells generate a message in the form of nerve impulse or hormone
3) Modulator/control centre - Processes the message received from receptor and sends the message to the effector
Message – New message sent out by modulator
4) Effector – The cell, gland or organ that receive the message from the modulator and carries out the response
5) Response – The effector organs bring out an appropriate reaction/change
6) Feedback – The original stimulus is changed by the response

Negative feedback
Feedback that reduces the effect of, or eliminates, the original stimulus.

Positive feedback
Feedback that reinforces the original stimulus

25. UNDERSTAND AND DESCRIBE THE TERM HOMEOSTASIS

Homeostasis
Homeostasis is the process whereby the body's internal environment is maintained in a steady state (within normal tolerance limits). Homeostasis mechanism are controlled by both the nervous and endocrine system. Both systems detect when the body is beginning to deviate from its normal balanced state

- The body works best within a narrow range of conditions
  - Temperature
  - Blood pressure
  - Fluid concentrations (osmotic, diffusion and electrochemical gradients)
  - Acidity (pH)
  - The concentration of nutrients, wastes and gases

- If conditions inside the body start to change the body automatically switches on control mechanisms that restore the optimal operating environment
  Eg- if our temperature goes up we sweat; if we lose too much fluid we feel thirsty.
- The ability to maintain the body's optimal working environment is referred to as homeostasis

26. DESCRIBE SOME OF THE COMMON CAUSES TO THE DISTRIBUTION OF HORMONES

- Either having too little or to much, of any hormone will have an impact in homeostasis.
- If any of the endocrine glands are malfunctioning in any way or form this will also have an impact on homeostasis

27. DESCRIBE SOME OF THE TREATMENTS FOR THE DISTRIBUTION OF HORMONES

- Drugs that either block or encourage production of the particular hormone that isn't being produced properly
- Surgery to fix the issue with the endocrine gland responsible for not producing the hormone properly

28. DESCRIBE SOME OF THE DISEASE ASSOCIATED WITH HOMEOSTASIS INCLUDING: DIABETES, HYPERTHYROIDISM AND HYPOTHYROIDISM

DIABETES

Symptoms

- Glucose in urine
- Large amounts of urine (glucose inhibits reabsorption of water)
- Unusual thirst
- Hunger

Causes

- Under secretion of Insulin
- Failure of cell receptors to respond to insulin

How it works

- Blood glucose is high, but it is unavailable to cells.
- Body becomes confused. Responds as if low in glucose. (Increased glycogenolysis and fat mobilisation)

Causes

1. Production of acidic products called ketones which causes disruption of the body pH.
2. Urine containing glucose

Treatment

Type 1 – Insulin injections/ programmable pump and careful monitoring of blood sugar levels
Type 2 – Dietary control, exercise, maintaining a healthy weight or sometimes medication

HYPERTHYROIDISM

To much thyroxine is produced by the thyroid gland (The cells become overs stimulated)

Symptoms;

- Rapid heart rate
- Weight loss
- Increased appetite
- Fatigue
- Anxiety

Treatments

- Drugs that block the thyroid gland
- Through surgery removing part of the thyroid gland
- Radiation

HYPOTHYROIDISM
Not enough thyroxine is produced by the thyroid gland

Symptoms
- slow heart rate
- Unexpected weight gain
- Fatigue / lack of energy
- Intolerance to cold
- Swelling of face

Treatments
- thyroxine molecules
- Change in diet

29. EXPLAIN HOW DRUGS, EXERCISE AND DIET CAN EFFECT HOMEOSTASIS

DRUGS
Many drugs help to maintain homeostasis
Eg- Drugs that treat high blood pressure, irregular hart rhythm, blood glucose level ect.

Non medical drug, such as alcohol or ecstasy, can also disrupt homeostasis. Many of them do this by binging go receptor proteins or neurons and others cells. This can either speed up or slow down nerve transmission to the brain

EXERCISE / DIET
Over exercise can cause disrupt homeostasis. If nutrition is inadequate, excessive exercise can cause the protein in muscle to be broken down for energy. Instead if building muscle, muscle mass may be reduced. This is a string link between eating disorders, such as anorexia.

OTHER NOTES *(NOT IN SYLLABUS)*

Nervous control of the heart
- The constant beat of the heart is brought about by the sinoatrial node (SV)
- The SV node by be influence by the sympathetic and parasympathetic division of the automatic nervous system
- Neuron to the heart and the walls of the blood vessels originate in the cardiac centre in the medulla
- Sympathetic nerve fibres make contract with the SV node, the AV node (atrioventricular node) and the part of the cardiac muscle
- Message from the hypothalamus stimulate the cardiovascular centre causing the sympathetic nerves to release noradrenaline and adrenaline which increase the heart rate and the strength of contraction
- Inhibiting impulses are sent along the parasympathetic fibres, which travel to the heart via the vagus nerve
- Stimulation of the parasympathetic nerve cause the release of acetylcholine which decreases the rate of the heart beat and the strength of contraction
- Parasympathetic dominate at rest, sympathetic increases during exercise

- Pressorecptors respond to changes in the blood pressure
- Increase in the blood pressure the cardiovascular centre
- Parasympathetic neurons are stimulated causing a decrease in the heart rate
- Cardio output is therefore decreased and the blood pressure falls

HIGH BLOOD PRESSURE

Stimulus
Increase in blood pressure
Increase cardio output (Q)
Eg-

Feedback
Decrease blood pressure
Decrease cardiac output

Receptors
Pressorecptors
- Aorta
- Cardiac arteries

Response
Decrease heart rate
Vasoconstriction

Modulator
Cardiac centre
- Medulla

Parasympathetic nervous system releases Acytocholine

Effector
Heart
- SA nodes

Blood vessels

LOW BLOOD PRESSURE

Stimulus
Decrease in blood pressure
Decrease cardio output (Q)
Eg-

Feedback
Increase blood pressure
Increase cardiac output

Receptors
Pressorecptors
- Aorta
- Cardiac arteries

Response
Increase heart rate
Vasoconstriction

Modulator
Cardiac centre
- Medulla

Sympathetic nervous system releases noradrenaline

Effector
Heart
- SA nodes

Blood vessels