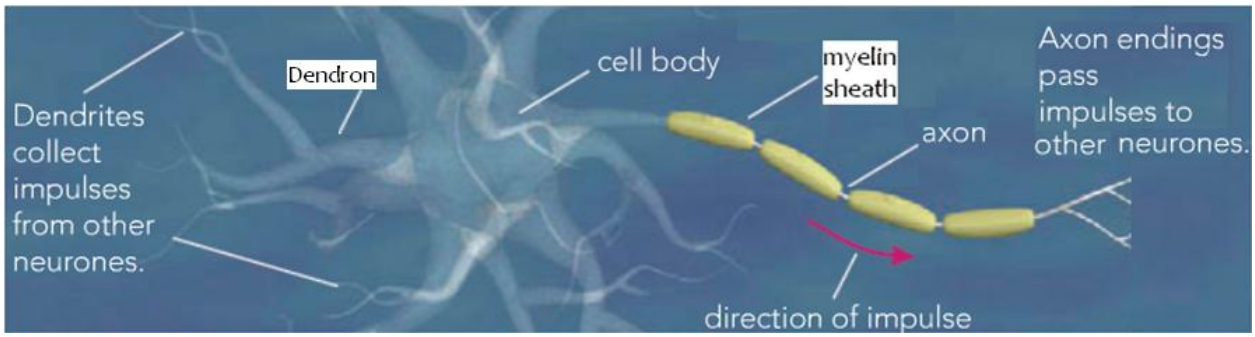
Topic 2 notes – Responses to a changing environment

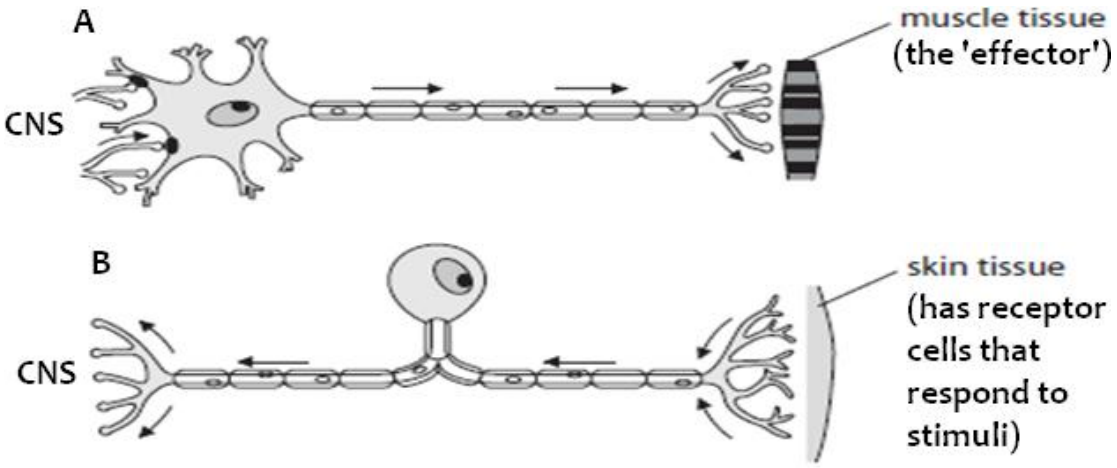
- **HOMEOSTASIS**
- The conditions inside the body (the 'internal environment) must remain stable
- Keeping the internal environment stable is called homeostasis
- **Controlling water and salt content - osmoregulation:**
- The control of water in the body is called osmoregulation
- The body loses water in urine, breath and sweat
- Kidneys can control the amount of water that is lost through urine…:
    - If the body has too much water, kidneys respond by producing more urine →more water is lost
    - If the body doesn't have enough water, kidneys produce less urine→less water is lost (the brain also responds by giving us a feeling of thirst)
- **Controlling body temperature – thermoregulation:**
- The control of body temperature is called thermoregulation
- Body temperature must be maintained at 37°C because...
    - Enzymes that help many chemical reactions to occur work best at this temperature
    - At too high temperatures, enzymes become denatured (lose their shape and stop working)
- A small part of the brain called the hypothalamus constantly monitors body temperature:
    - It receives information from nerve endings in the dermis of the skin about the temperature outside the body
    - It receives information about the temperature inside the body from the blood
- **If the body temperature goes <u>below</u> 37°C:**
    - **1. Shivering**
        - The hypothalamus causes muscles to shiver - shivering releases heat which warms you up
    - **2. Hairs stand on end**
        - The hypothalamus causes erector muscles in the dermis to contract →body hairs stand upright
        - This traps more air next to the skin, providing insulation
    - **3. Vasoconstriction**
        - Hypothalamus causes blood vessels to narrow ('vasoconstriction')
        - →blood flow to the surface of the skin is reduced→less heat loss
- **If the body temperature goes <u>above</u> 37°C:**
    - **1. Sweating**
        - The hypothalamus causes sweating
        - As sweat evaporates it transfers heat energy from the skin to the surroundings→the skin cools down
    - **2. Hairs lie flat**
        - The hypothalamus causes erector muscles in the dermis to relax →they lie flat→no heat is trapped between hairs→cools us down
    - **3. Vasodilation**
        - Hypothalamus causes blood vessels to widen ('vasodilation')
        - →blood flow to the surface of the skin is increased→more heat loss

- Thermoregulation is an example of negative feedback:
    - This means that as a change to the body happens in one direction, mechanisms in the body work to make it change in the opposite direction
    - E.g if we get too hot, mechanisms in the body help us to cool down
    - Negative feedback helps keep conditions in the body around the right level
- **HORMONES**
- Hormones are produced and then released by endocrine glands into the bloodstream, where they are then transported around the body
- Once in the blood, hormones act as 'chemical messengers', causing certain parts of the body to respond to their presence
- An organ that responds to a certain hormone is called a 'target organ'
- **Controlling blood glucose levels:**
- High blood glucose levels cause tiredness and can damage organs
- Low blood glucose levels may cause unconsciousness
- →The concentration of glucose in the blood must be kept constant...
- 1. When blood glucose levels are too high (often after a meal):
    - The pancreas releases a hormone called insulin
    - Insulin is transported in the blood to the liver
    - Insulin causes liver cells to take glucose out of the blood and convert it into glycogen (glycogen acts as a store of glucose because it can be converted back into glucose when required)
    - →blood glucose concentration decreases (back to normal)
- 2. When blood glucose levels are too low:
    - The pancreas releases a hormone called glucagon
    - Glucagon is transported in the blood to the liver
    - Glucagon causes liver cells to convert glycogen back into glucose, which is then released into the blood
    - →blood glucose concentration increases (back to normal)
- The control of blood glucose concentration is an example of a negative feedback mechanism
- **DIABETES**
- People who have a disease called diabetes can't control their blood glucose levels very well – there are two types of diabetes
- **Type 1 diabetes:**
- Diabetes Type 1 (develops in young people) - pancreas does not produce any insulin
- →when blood glucose concentrations rise, the body cannot bring them back down to normal
- Controlling type 1 diabetes:
    - **1.** Inject insulin into fat layer beneath skin (this helps diabetics keep their blood glucose levels low)
    - **2.** Exercise reduces blood glucose levels, eating fatty foods increases blood glucose levels
    - →by exercising more and not eating fatty foods, diabetics can keep their blood glucose levels low→they don't need to inject as much insulin
- **Type 2 diabetes:**
- In this type of diabetes, the pancreas releases insulin as normal
- However, the cells in a person's body don't respond well to insulin (they become 'resistant' to insulin)→person has problems in reducing blood sugar levels

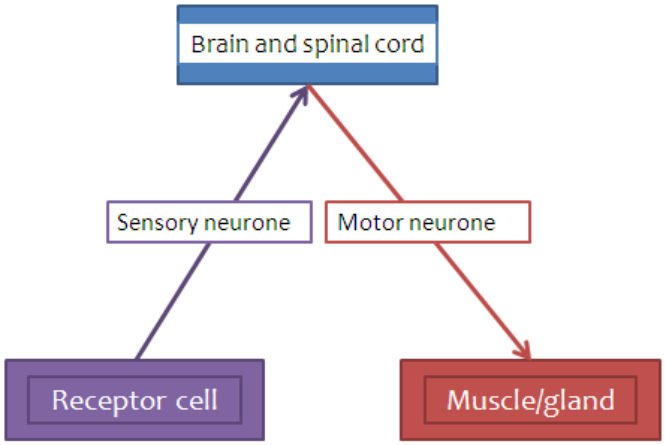
- Unlike Type 1 diabetes which develops in young people, Type 2 diabetes usually develops in adulthood
- Risk factors for Type 2 diabetes: high fat diets, lack of exercise, obesity, age
- Body Mass Index (BMI):
    - Doctors class people as obese if they have a BMI of over 30
    - BMI gives an estimate of how healthy a person's mass is for their height
    - Equation: BMI = weight in kilograms / (height in metres)^2
    - Correlation between high BMI and suffering Type 2 diabetes
- Unlike Type 1 diabetics, sufferers of Type 2 diabetes don't need to inject themselves with insulin
- Controlling type 2 diabetes:
    - No need to inject insulin
    - Can be controlled by changing diet (eating less fatty/sugary foods) and by exercising more
- **NERVOUS SYSTEM**
- **Neurones:**
- Electrical impulses travel along bundles of nerves called <u>neurones</u>
- General neurone structure:



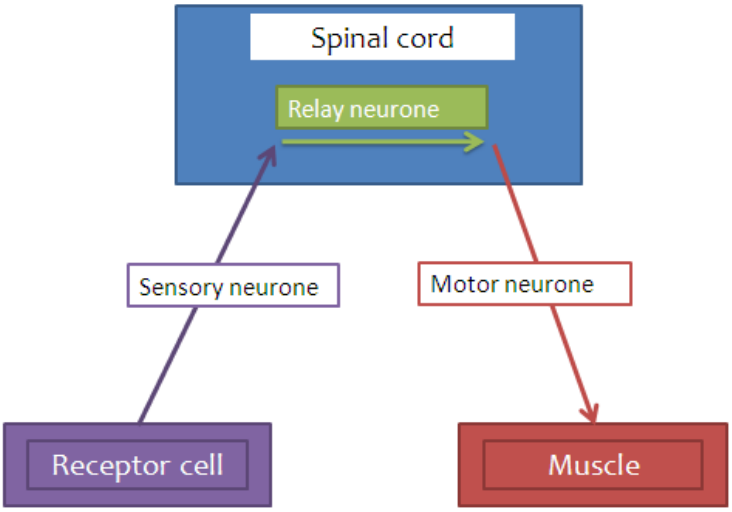
- **Neurotransmission – how impulses travel along neurones:**
- Dendrites receive impulses from receptor cells or other neurones
- Impulses move along the dendron, past the cell body and to the axon
- When impulses reach axon endings ('terminals'), chemicals called neurotransmitters are released across the gap ('synapse')
- This causes the electrical impulse to be passed on to other neurones
- Many neurones have a fatty layer surrounding the axon – this is called the myelin sheath:
    - It helps to insulate the axon from surrounding tissue
    - It allows impulses to travel faster
- **Responding to stimuli (co-ordinated/conscious responses):**
- Anything the body is sensitive to is called a stimulus
- Sense organs in the body contain 'receptor cells', which detect stimuli
- There are three different types of neurones:
    - Sensory neurone (fig. B)
    - Relay neurone
    - Motor neurone (fig. A)



- When a stimulus is detected, receptor cells create electrical signals – called <u>impulses</u> – which travel along sensory neurones (Fig.B) in the spinal cord to the brain ('central nervous system' – CNS)
- Brain processes the information and electrical impulses are then sent along motor neurones (Fig.A) to effectors (e.g muscles, glands), which carry out the response



- **The reflex arc:**
- Reflex actions are responses that are automatic, extremely quick and protect the body from injury (e.g moving finger away from hot object prevents burning)
- Reflexes use neurone pathways called <u>reflex arcs</u>:
    - Receptor cells detect the stimulus (e.g hot object) and cause electrical impulses to travel along a sensory neurone
    - Sensory neurone synapses with a relay neurone in the spinal cord
    - Impulse then travels from a relay neurone to a motor neurone
    - Motor neurone carries impulse to the effector (muscle)
    - Muscle contracts→finger is pulled away from the hot object
- Reflex arcs <u>don't</u> pass by the brain (only pass by the spinal cord)→reflex responses don't require conscious thought
- →Reflex responses are quicker than coordinated responses (e.g kicking of a football...or...shivering), which instead do involve conscious thought



- **PLANT HORMONES**
- **Phototropism:**
- Responding to a stimulus by growing towards or away from it is called a tropism
- A tropism caused by light is called a phototropism
- A tropism away from a stimulus is a negative tropism
- A tropism towards a stimulus is a positive tropism
- **Auxins and positive phototropism in shoots:**
- Plant shoots grow towards sunlight – 'positive phototropism'
- Plants do this because they need sunlight for photosynthesis
- This positive phototropism in shoots is caused by plant hormones called auxins
- Auxins are produced in the tips of shoots, where they cause elongation of cells:
    - If a shoot is grown with light coming from only one direction, auxins move to the shaded side of the shoot
    - The presence of auxins makes the cells on the shaded side elongate more →causing the shoot to grow upwards towards the light
- Note: auxins are only present at the tips of shoots→if the tips are cut then auxins are removed→shoots will not grow towards the light source
- **Auxins and positive gravitropism in roots:**
- Root tips grow downwards in the direction of gravity – 'positive gravitropism'
- Roots do this because it helps them anchor the plant in place and reach moisture underground (important because water is needed for photosynthesis)
- This positive gravitropism in roots is also caused by auxins...
- In root tips, auxins have the opposite effect to that in shoots (i.e they inhibit cell elongation instead of promoting it):
    - Auxins accumulate on the bottom side of root tips and stop these cells elongating→causing the root to bend downwards towards gravity
- **Gibberellins stimulate growth of seeds:**
- When a seed germinates, roots and a shoot start to grow
- Some seeds need periods of darkness or cold before they will germinate
- Once this period is completed, the seed releases plant hormones called gibberellins
- Gibberellins cause starch stored in a seed to be turned into sugars that the seed uses as energy to grow
- Gibberellins also stimulate flower and fruit production in some plant species

- **USES OF PLANT HORMONES**
- **Selective weedkillers:**
- In the Vietnam War, a weedkiller containing artificial auxins called Agent Orange was used to destroy the jungle so that the Americans could see enemy movements
- Artificial auxin is still used as a selective weedkiller because it only makes plants with broad leaves (e.g daisies) grow out of control and die - plants with narrow leaves (e.g wheat and grass) are unaffected
- →Farmers can kill all the weeds in a field without affecting their crop
- **Rooting powder**
- Artificial auxins are also used in rooting powders
- Dipping plant cuttings (parts of plants) in rooting powder→much faster root growth compared to growing plants from seed
- **Seedless fruit:**
- Some seedless fruits are produced using plant hormones
- Other plants, like some varieties of grape, are naturally seedless but have small fruits→the fruits are sprayed with gibberellins to increase their size
- **Fruit ripening:**
- Plant hormones naturally control the ripening of fruits→farmers can used plant hormones to control when and how ripening occurs…e.g:
    - Plant hormones are sprayed onto Fruit trees to stop the fruit falling off. This stops fruits falling and becoming damaged and also allows the fruit to grow bigger
    - Plant hormones sprayed onto Fruit trees also speed up ripening so that all the fruit ripens together and can be picked off the trees all in one go
    - Plant hormones are sprayed onto unripe fruit to make them ripe