Section 9.1 – Sensory Reception

- A stimulus is a detectable change in the internal or external environment of an organism that produces a response.
- The ability to respond to a stimulus increases an organism's chances of survival.
- Receptors transfer the energy of a stimulus into a form that can be processed by the organism and leads to a response.
- The response is carried out by "effectors" which can include cells, tissues, organs and systems.

Taxis – A simple response that's direction is determined by the direction of the stimulus

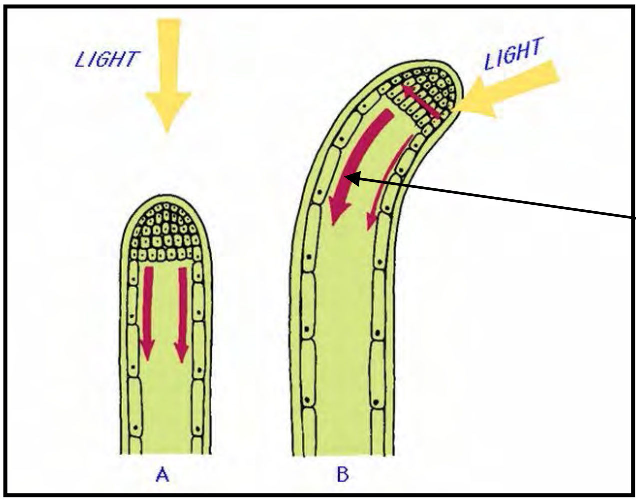
An organism can respond directly to a change in the environment by moving its body either:

1.) Toward the stimulus (positive taxis)
2.) Away from the stimulus (negative taxis)

Kinesis – Results in an increase of random movements

- Organism does not move towards/away from the stimulus
- The more intense the stimulus the more rapid the movements
- Kinesis is important when the stimulus is less directional such as heat or humidity

Tropism – a growth movement of part of a plant in response to a directional stimulus



Positive phototropism – shoots/leaves
Positive Geotropism – roots

Light causes a protein that a affects growth factor to move to the left side of the plant causing that side to grow more rapidly. More growth on the left side causes the plant to bend towards the source of light.

Section 9.2 – Nervous Control

<u>Nervous organisation</u>

The nervous system can be thought of as having two main divisions:

1.) The central nervous system (CNS) – brain and spinal cord
2.) The peripheral nervous system (PNS) – Made up of pairs of nerves that originate either from the brain or the spinal cord

<u>The peripheral nervous system</u>

This is divided into:

- Sensory neurons which carry impulses away from receptors to the CNS
- Motor neurons which carry nervous impulses from the CNS to effectors

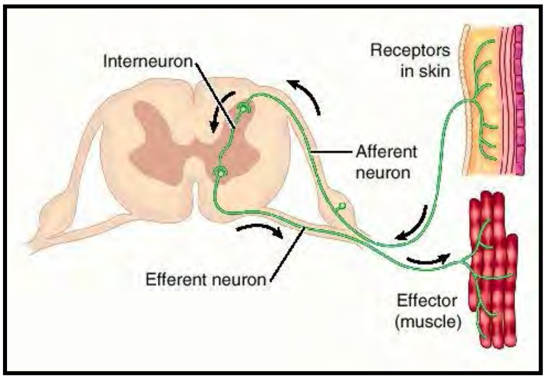
The spinal cord is a column of nervous tissue

A reflex – involuntary response to a stimulus (you do stop to consider an alternative)

The pathway of neurons involved in a reflex is called a reflex arc.

Reflex arcs contain just 3 neurons:

1.) A sensory neuron
2.) An intermediate neuron
3.) A motor neuron



Efferent neuron – motor neuron
Afferent neuron – sensory neuron

There are several stages of a reflex arc:

1.) Stimulus
2.) Receptor
3.) Sensory neuron
4.) Synapse
5.) Coordinator (intermediate neuron)
6.) Synapse
7.) Motor neuron
8.) Effecter
9.) Response

<u>Importance of the reflex arc</u>

- **Involuntary** – does not require the decision making power of the brains
- Brain can override the response if necessary
- Protects the body from harmful stimuli
- **Effective from birth** – does not need to be learnt
- **Short pathway** – fewer synapses

Synapses – slow
Neurons – fast

Section 9.3 – Control of heart rate

The Autonomic nervous system

Controls subconscious activities of muscles and glands
Has two main divisions:
The sympathetic nervous system – Speeds up activities and thus allows us to cope with stressful situations (fight or flight response)
The parasympathetic nervous system – Inhibits effects and slows down activities. This allows energy to be conserved. Controls under normal resting conditions

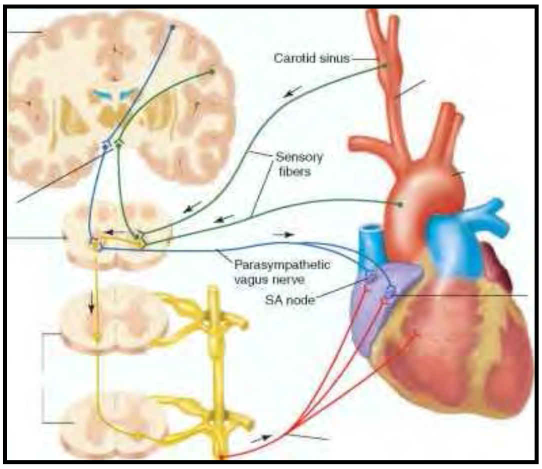
The two divisions are **antagonistic** meaning that their effects oppose one another

Control of heart rate

Changes of the heart rate are controlled by a region of the brain called the medulla oblongata which has two main divisions
One division is connected to the sinoatrial node through the sympathetic nervous system
The other is connected to the sinoatrial node via the parasympathetic nervous system

Control by chemoreceptors

Chemoreceptors are found in the wall of the carotid arteries and detect changes in pH as a result of CO_2 concentration
When CO_2 concentration in the blood is too high, chemoreceptors detect the drop in pH and send impulses to the section of the medulla oblongata responsible for increasing heart rate
This section then increases the number of impulses sent to the S.A node via the sympathetic nervous system
This results in an increase in heart rate which then causes blood pH to return to normal.



Control by pressure receptors

Pressure receptors occur in the wall of the carotid arteries and the aorta
When blood pressure is too high – impulses are sent to the medulla oblongata which then sends impulses to the S.A node via the parasympathetic nervous system decreasing the heart rate
When blood pressure is too low – impulses are sent to the medulla oblongata which then sends impulses to the S.A node via the sympathetic nervous system, increasing the heart rate

Section 9.4 – Role of receptors

Features of sensory reception

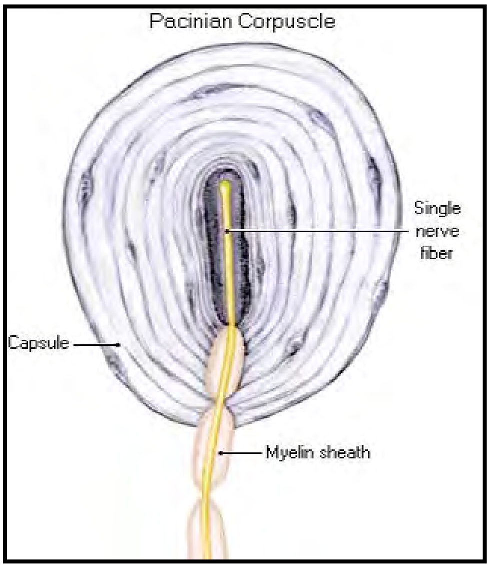
A sensory receptor will:

- Only respond to a specific type of stimulus (e.g. light, pressure, etc)
- Produce a generator potential by acting as a transducer. This means that it can convert the information to a form that the human body can interpret. This is achieved by using the energy of a stimulus into a nerve impulse called a **generator potential**.

Structure and function of a pacinian corpuscle

Responds to mechanical pressure
Occurs in ligaments and joints so that it is possible to tell which direction a joint is changing
The neuron of a pacinian corpuscle is in the centre of layers of tissue, each separated by gel
The sensory neuron of a pacinian corpuscle has stretch-mediated sodium channels in its plasma membrane

- During its resting state, stretch-mediated sodium channels are too narrow to allow sodium through. The corpuscle therefore has a resting potential
- When pressure is applied, the membrane of the neuron is stretched causing sodium channels to widen therefore allowing sodium to diffuse into the neuron
- The influx of sodium ions cause a change in the polarity of the neuron, creating a resting potential
- The generator potential creates a action potential which moves along the neuron



Receptors working together in the eye

Different receptors respond to a different intensity of a stimulus
Light receptors of the eye are found in the retina (the inner most layer)
The light receptors in the eye can are of two types, rod and cone cells. Both receptors convert light energy into a nervous impulse and are therefore acting as transducers

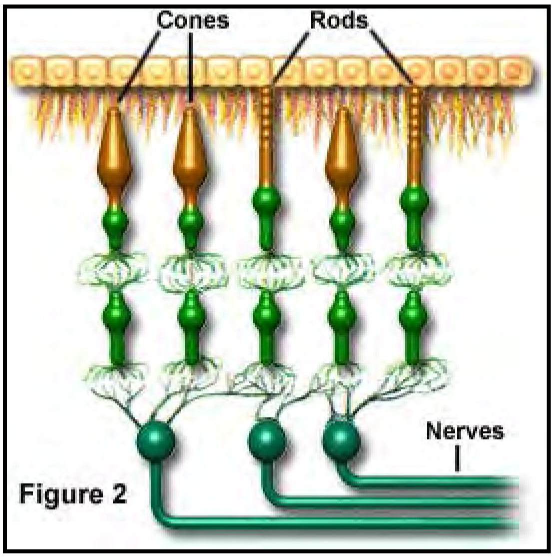
Rod cells

Cannot distinguish between different wavelengths
Many rod cells are connected to the same neuron and so can function at low light intensities.

A threshold must be reached in the bipolar cells to which they are attached to and so since they can all contribute to reaching this threshold, they will function at lower light intensities
Rod cells breakdown the pigment **rhodopsin** to generate an action potential.
Rhodopsin is easily broken down in low light intensity
Since more that one rod cell is connected to the same neuron, only one impulse will be generated. It is impossible for the brain to determine which rod cells were stimulate to begin with and so it is not possible to determine exactly the source of light
This results in rod cells having a relatively poor visual acuity and so are not very effective in distinguishing between two points close together

Cone cells

There are three types of cone cells, each of which respond to a different wavelength
The colour interpreted depends of the proportion of each type of cone cell stimulated
Cone cells are connected only to one bipolar cells, this means that they cannot combine to reach a threshold. As a result of this a high light intensity is required to create a generator potential
Cone cells breakdown the pigment iodopsin to create a generator potential
Iodopsin can only be broken down by a high light intensity
Since cone cells are connected to a single bipolar cell, when two adjacent cells are stimulated, two separate nervous impulses will be sent to the brain. This means that it is easier to determine the source of the light. As a result, cone cells are responsible for higher visual acuity since they allow you to better distinguish between two points



Light is concentrated by a lens to the centre of the eye called the fovea. This region receives a high light intensity and therefore has more cone cells. The peripheries of the eye receive a low light intensity and therefore consist mainly of rod cells.