Human response to the environment

Scope

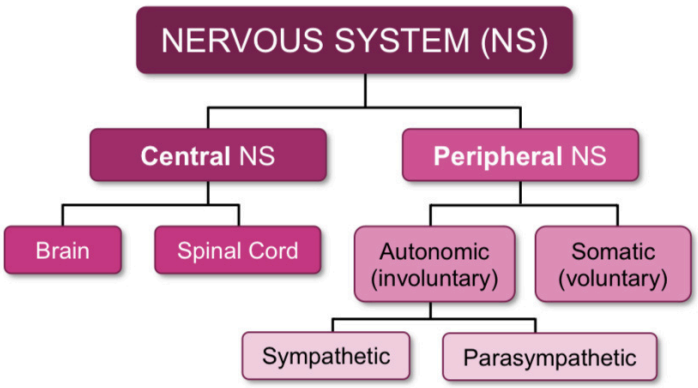
TOPIC	SUBTOPIC	KEY INFORMATION
RESPONDING TO THE ENVIRONMENT HUMANS	Central nervous system: The brain & spinal cord	• Protection of the parts + diagrams with labels & functions of parts • Only parts given in Examination Guidelines
	Peripheral nervous system	• Location, structure and functions of different neurons • Only parts given in Examination Guidelines
	Autonomic nervous system	• Differentiate between sympathetic and parasympathetic actions
	Neurons, reflex actions and the reflex arc	• A reflex arc and the role of each part, using a diagram • Differences between a reflex action and a reflex arc
	Disorders of the CNS	• Causes and symptoms of: ✓ Alzheimer's disease ✓ Multiple sclerosis
	The eye	• Parts and functions using diagrams, binocular & stereoscopic vision
	Accommodation	• Interpret diagrams as well as identify and name the parts plus their roles involved in the process (for near and far vision) • Refer to MTG & Diagnostic report
	Pupillary mechanism	• Interpret diagrams as well as identify and name the parts plus their roles involved in the process (in dark and light environments) • Refer to MTG & Diagnostic report
	Visual defects	• Interpret diagrams and treatment of each of myopia, hypermetropia, astigmatism and cataracts
	The ear	• Parts and functions using diagrams • Emphasise the use of the correct scientific terms
	Hearing	• The whole process starting with the pinna to the Corti- organ and then to the cerebrum via the auditory nerve
	Balance	• The role of the macula, cristae and auditory nerve - to the cerebellum
	Hearing defects	• Causes and treatment of middle ear infection and deafness

Adapted from DBE revision guidelines

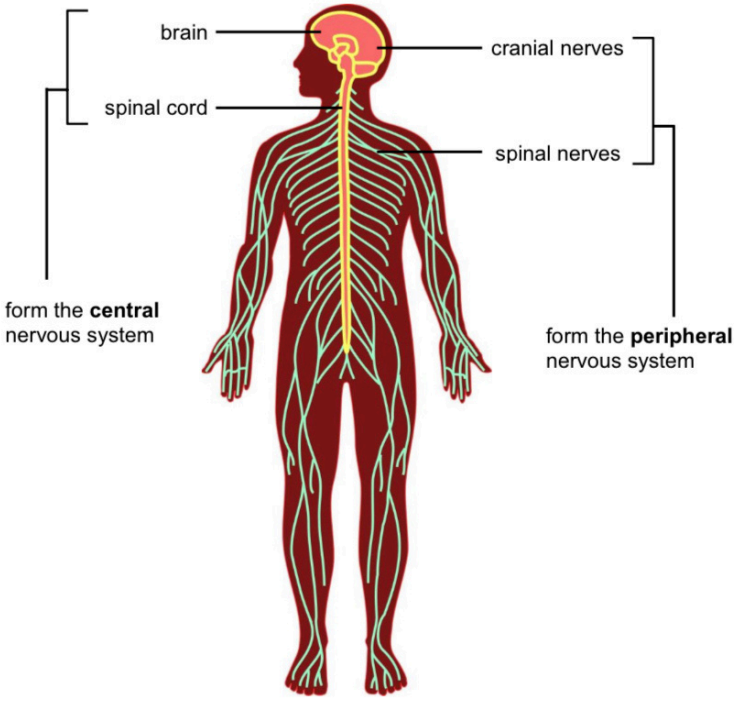
Human response to the environment Notes

The human nervous system with its receptor organs allows the body to respond.

Human Nervous System



CNS & PNS



Peripheral Nervous System

Consist of:

• autonomic part which is involuntary (one that can't be controlled)

• somatic part which is voluntary (under conscious control).

Examples of a voluntary action

- running
-jumping
- eating
- walking.

Examples of Involuntary actions, or reflex actions

- breathing
- sneezing.

Autonomic Nervous System

The autonomic part may be further divided into the sympathetic and the parasympathetic systems, which work antagonistically (in an opposing manner).

Sympathetic division:

• Responsible for fight/flight

Parasympathetic division:

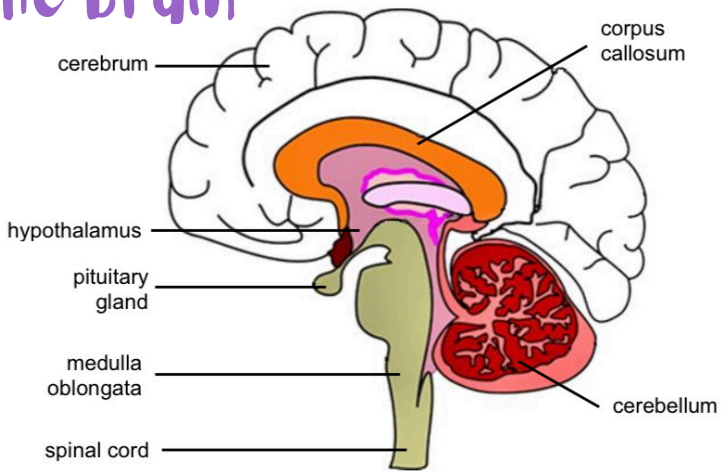
• Return body to rest

Human response to the environment

Central Nervous System

The central nervous system is made up of the brain and spinal cord.

The brain



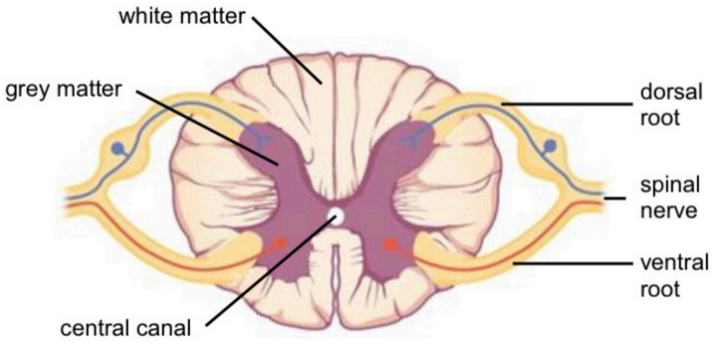
Protection of brain

- cranium
- 3 meninges (pia,dura & arachnoid matter)
- cerebrospinal fluid

Functions of brain

Structural adaptation	Function
cerebrum	
• the largest part of the brain • divided into two hemispheres (left and right) which are connected by the **corpus callosum**	• controls voluntary functions (walking, speaking, writing) • receives and interprets sensations from sense organs (hearing, sight, feeling, taste, smell) • higher thought processes (memory, intelligence, reasoning) • to allow communication between the two halves of the brain
cerebellum	
• second largest part of the brain • located behind and below the cerebrum	• co-ordinates skeletal muscles to bring about balance while moving, as in walking or running • maintains balance and posture • maintains muscle tone
medulla oblongata	
• lower part of the brain • continues down into the body as the spinal cord	• controls breathing, peristalsis, heartbeat, swallowing • transmits impulses from the spinal cord to the brain • controls less important reflexes: blinking, coughing, sneezing, vasodilation, vasoconstriction and salivating
hypothalamus	
• a small section of the brain just above the pituitary gland	• a control centre for things such as hunger, thirst, sleep, body temperature, emotions

Spinal cord



Functions of Spinal cord

The spinal cord has the following functions:

- transmits impulses from receptors to the brain and from the brain to the effectors
- contains reflex centres that function automatically to protect the body

Protection of Spinal cord

- Vertebral column
- 3 meninges (pia,dura & arachnoid matter)
- cerebrospinal fluid

The corpus callosum serves as a communication bridge between left & right hemisphere by connecting them.

Human response to the environment

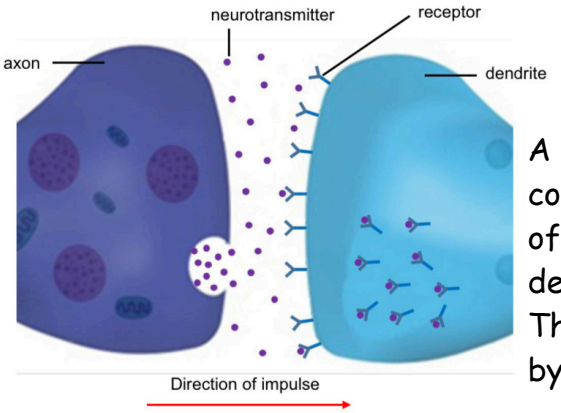
Peripheral Nervous System

The peripheral nervous system is made up of cranial & spinal nerves

Neurons

A neuron is a single nerve cell.
neurons have the following structures:

- dendrites – transmitting impulses towards the cell body
- a cell body - controlling the metabolism of the cell
- an axon – transmitting impulses away from the cell body
- a myelin sheath – insulating the axon to speed up transmission of impulses; neurilemma helps to repair damaged neurons



Synapse

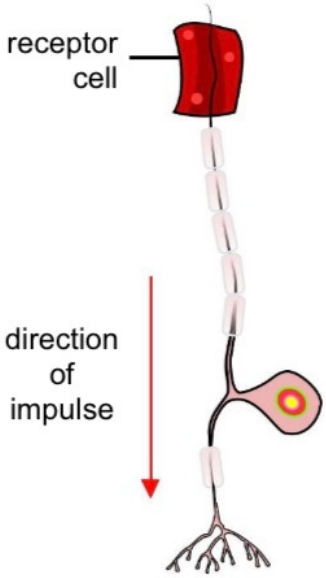
A synapse is a functional connection between the axon of one neuron and the dendrites of another neuron. The connection is established by neurotransmitters.

Significance of a synapse:

- It ensures that the impulse moves in one direction only
- It prevents continuous stimulation of the neurons
- ensures that the impulse is transmitted from the sensory neuron to the motor neuron

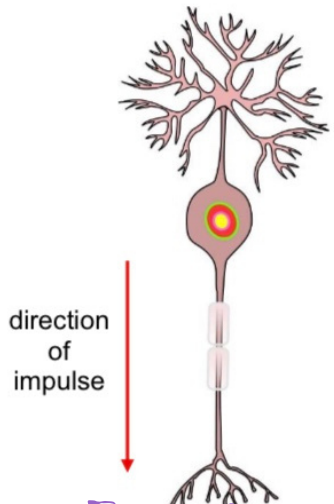
Three types of neurons: Motor, sensory & interneuron

Sensory neuron



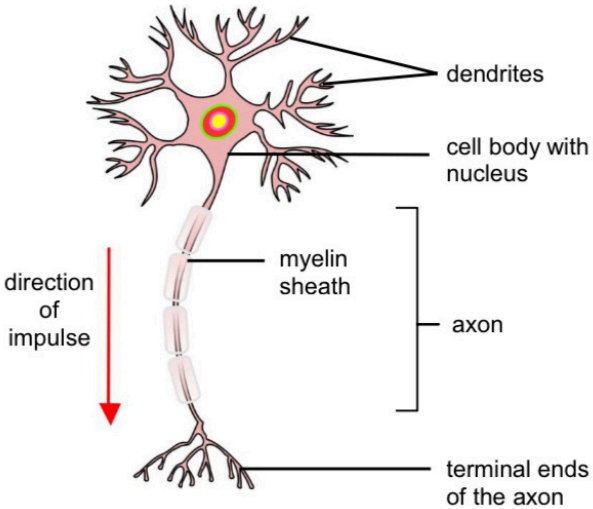
Sensory neurons transmit impulses from receptors to the central nervous system.

Inter neuron



An interneuron connects a sensory neuron to a motor neuron in the central nervous system.

Motor neuron



Motor neurons transmit impulses from the central nervous system to the effectors (muscles and glands) in the body.

Functions

Impulse is transmitted from dendrite to axon!

Human response to the environment

Peripheral Nervous System

Somatic Nervous system

The somatic nervous system controls voluntary (skeletal) muscles. The nerves in this system allow the body to react to changes in the external environment.

Autonomic Nervous system

The autonomic nervous system controls involuntary actions. The nerves in this system allow the body to react to changes in the internal environment so that homeostasis can be maintained.

The autonomic nervous system can be subdivided into the sympathetic nervous system and the parasympathetic nervous system.

Sympathetic system	Parasympathetic system
increases heart rate	decreases heart rate
constricts blood vessels in the skin (vasoconstriction)	dilates blood vessels in skin (vasodilation)
increases blood pressure	decreases blood pressure
widens bronchioles	narrows bronchioles
decreases peristalsis	increases peristalsis
causes relaxation of the bladder wall	causes contraction of the bladder wall
stimulates sweat secretion	no effect
dilates pupils	constricts pupils
stimulates secretion of adrenalin	no effect

Human response to the environment

Reflex action & arc

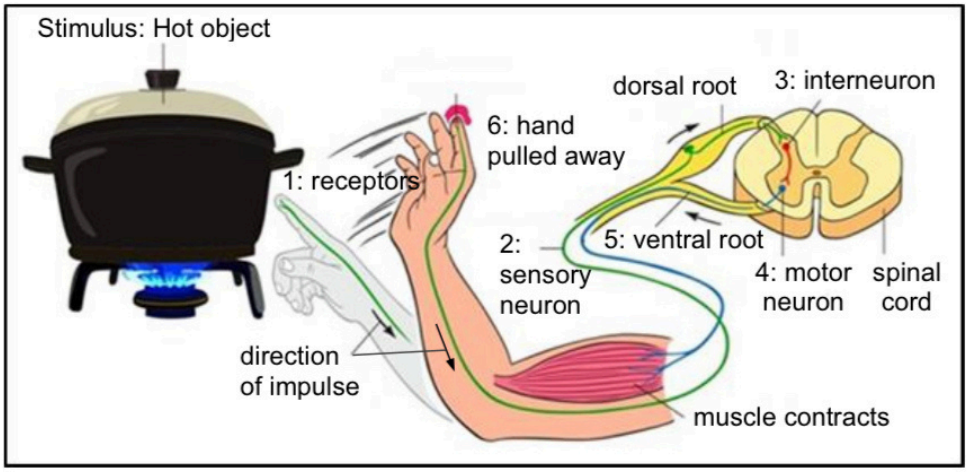
Reflec action

A reflex action is a quick, automatic response to a stimulus.
Examples: knee-jerk, sneezing and quickly removing a body part away from danger to respond to pain.

Reflec arc

A reflex arc is the pathway along which an impulse is transmitted to bring about a response to a stimulus during a reflex action.

Significance of Reflex action:
The reflex action allows for a quick response, without thinking about it, to prevent damage to the body.



Note!

If 2 stops working:
• person touches stove, doesnt feel pain, doesn't move hand, gets injured

If 4 stops working:
• person touches stove, feels pain, doesn't move hand, gets injured

The reflex action of a person touching a hot pot:
1. The stimulus is detected by receptors and converted into a nerve impulse.
2. The nerve impulse is transmitted along the sensory neuron through the dorsal root to the spinal cord.
3. The impulse is transmitted from the sensory neuron to an interneuron in the spinal cord.
4. The impulse is transmitted from the interneuron to a motor neuron in the spinal cord.
5. The impulse exits the spinal cord through the ventral root and is transmitted along the axon of the motor neuron to the effector organs (muscle; this causes the muscles in the arm to contract).
6. The hand pulls away from the stimulus quickly.

Human response to the environment

Disorders

Alzheimer's disease

Alzheimer's disease is a neurodegenerative disease which means there is progressive brain cell death that occurs over time. The disease is irreversible.
It is not yet known what causes the disease.
There is no known cure but the symptoms can be managed.

Symptoms:
- memory loss
- confusion

Multiple sclerosis

Multiple sclerosis is a disease that affects young adults between the ages of 20 and 40. The body's immune system attacks the myelin sheath covering neurons which prevents them from functioning properly. The reason why this happens is unknown. There is no known cure for this disease.

Symptoms:
- loss of speech and vision
- difficulty walking
- pain
- fatigue
- memory loss

Human nervous system

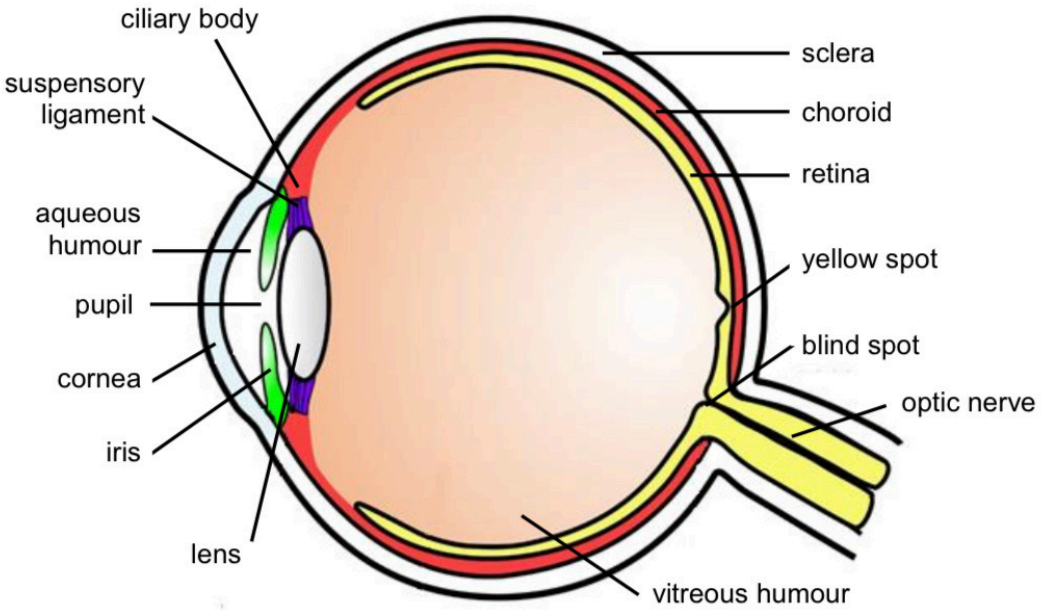
Terminology

Biological term	Description
Sensory neuron	Neuron that carries impulses to the Central Nervous System
Alzheimer's Disease	Progressive mental deterioration that can occur in middle or old age, due to generalized degeneration of the brain
Autonomic nervous system	The part of the peripheral nervous system that controls involuntary actions
Axon	The long threadlike part of a nerve cell along which impulses are conducted from the cell body to other cells
Central nervous system (CNS)	The part of the nervous system that consist of the brain and spinal cord
Cerebrospinal fluid	A watery *fluid*, continuously produced and absorbed, which flows in the ventricles (cavities) within the brain and around the surface of the brain and spinal cord
Corpus callosum	The structure that connects the left and right hemispheres of the brain, allowing communication between them
Dementia	A general term used for memory loss and loss of other intellectual abilities
Dendrite	A part of the neuron that conducts impulses towards the cell body
Motor neuron	Neuron that carries impulses from the CNS To effector
Effectors	Are muscles or glands that respond to the message from the nervous system (brain and spinal cord)
Medulla oblongata	The part of the brain that controls the heart rate
Meninges	A collective name for the membranes that protect the brain
Multiple sclerosis	A disorder of the nervous system that is characterised by the breakdown of the myelin sheath of neurons
Myelin sheath	A fatty layer wrapped around the axon, which acts as insulation
Nerve	Bundle of neurons
Neuron	One nerve cell
Neurotransmitter	Chemical that is released from a nerve cell which thereby transmits an impulse from a nerve cell to another nerve, muscle, organ, or other tissue
Peripheral nervous system	The part of the nervous system made up of cranial and spinal nerves
Receptors	Structures located in the sense organs. They convert a stimulus into an impulse
Stimulus	A detectable change (e.g. pain, heat, light, sound) that will be received by a receptor and converted into an impulse
Synapse	A junction between two nerve cells, consisting of a minute gap across which impulses pass by diffusion of a neurotransmitter

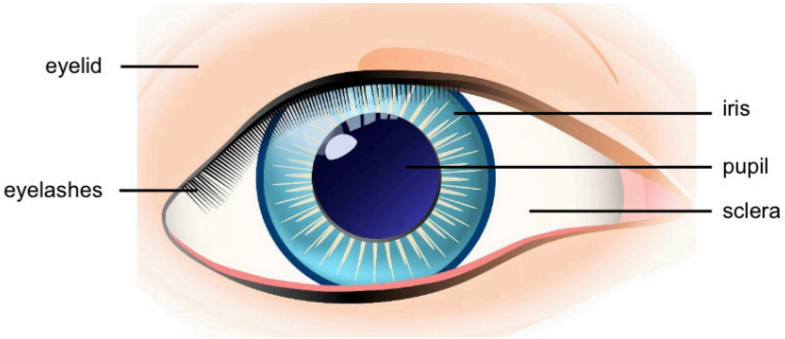
Human response to the environment

The Eye

Side view



Front view



Imaging in the eye

Two types of imaging occur:

- Binocular vision: vision using two eyes with overlapping fields of view so that the separate images are combined and interpreted as one image by the brain.
- Stereoscopic vision: the ability to form three dimensional images which provides the ability to judge distance, depth and the size of an object.

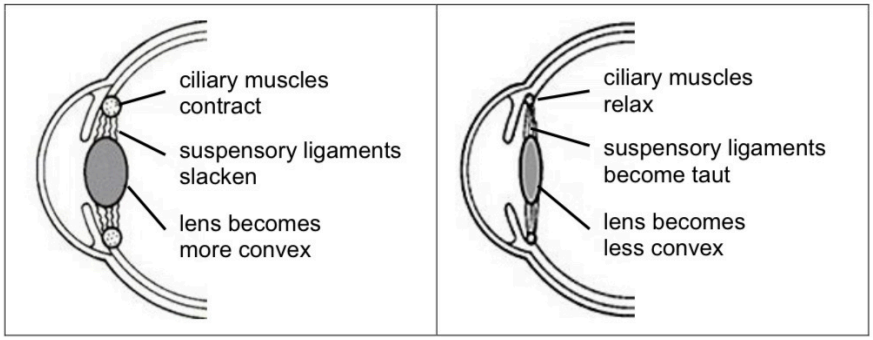
Human response to the environment

The Eye

Accomodation

Accommodation is the ability of the eye to alter the shape of the lens to ensure that a clear image always falls on the retina whether the object is near or distant.

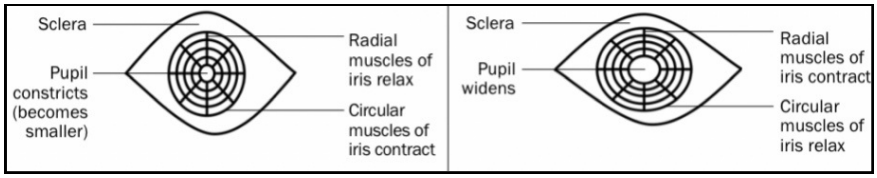
Near vision (***less*** than 6 m from the object)	**Distant vision** (***more*** than 6 m from the object)
• ciliary muscles contract • suspensory ligaments slacken (loosen) • tension on the lens decreases • lens becomes more convex (bulgy) • this causes light rays to bend more • a clear image is focused on the retina	• ciliary muscles relax • suspensory ligaments tighten (become taut) • tension on the lens increases • lens becomes less convex (flatter) • this causes light rays to bend less • a clear image is focused on the retina



Pupillary mechanism

Pupillary mechanism refers to the process by which the diameter of the pupil is altered to control the amount of light entering the eye.

Bright light conditions	**Dim light conditions**
• radial muscles cause iris to relax • circular muscles of the iris contract • the pupil constricts (gets smaller) • the amount of light entering the eye is reduced	• radial muscles cause iris to contract • circular muscles of the iris relax • the pupil widens (gets bigger) • the amount of light entering the eye is increased



Human response to the environment Visual defects

Short-sightedness

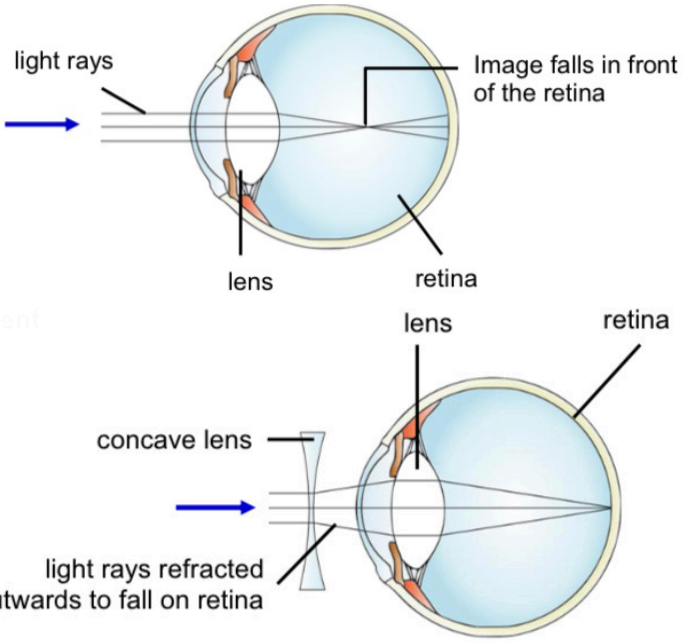
Short-sightedness occurs when a person has the ability to see nearby objects but cannot see distant objects clearly.
When looking at distant objects, the light rays focus in front of the retina, causing blurred vision.

Caused by:

- an eyeball that is too long
- the cornea being too curved
- the inability of the lens to become less convex

Treatment:

- wear glasses with concave lenses



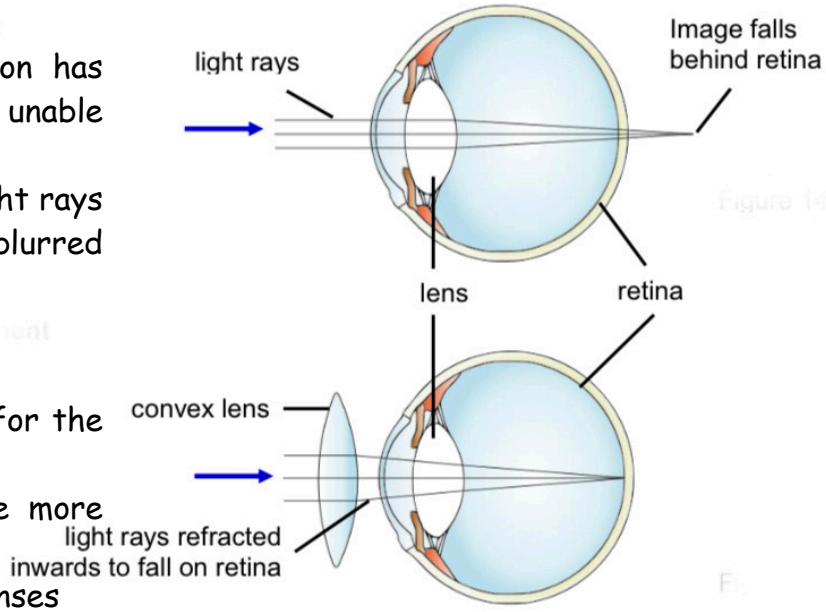
Long-sightedness

Long-sightedness occurs when a person has the ability to see distant objects but is unable to see nearby objects clearly.
When looking at nearby objects, the light rays focus behind the retina, causing blurred vision.

Caused by:

- an eyeball that is too short (rounded)
- the cornea not being curved enough for the length of the eyeball
- the inability of the lens to become more convex

Treatment: wear glasses with convex lenses



Astigmatism

Astigmatism occurs when the cornea or lens is not equally rounded in all directions as it normally would be

Leads to: blurred vision, headaches orsquinting of the eyes

Treatment of astigmatism may include:

- glasses with prescription lenses
- contact lenses
- laser therapy

Cataracts

Cataracts occur when the clear transparent lens becomes cloudy. This prevents light from entering the eye and results in blurred vision.

Treatment:

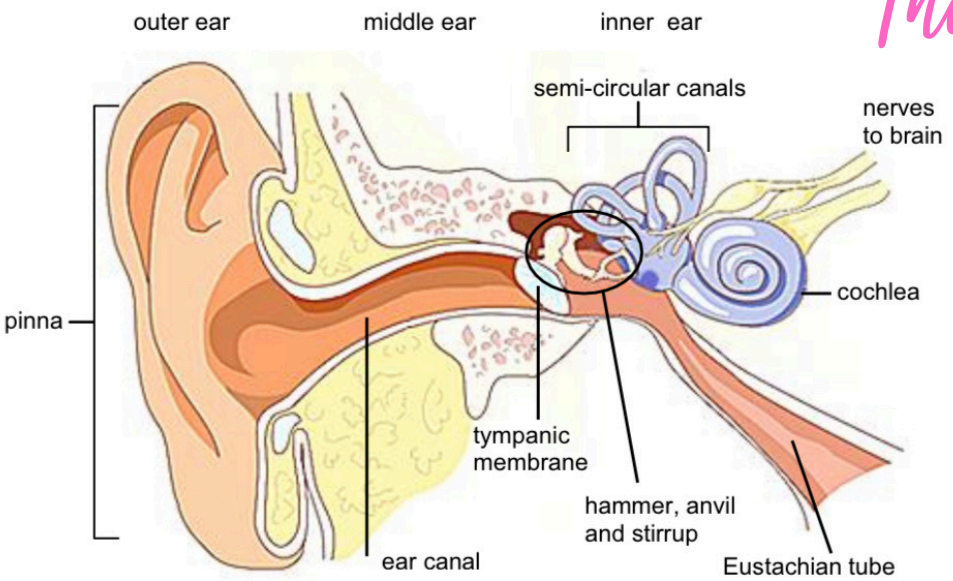
- In the beginning, spectacles may be used.
- As the cataract develops, surgery may be required

The Eye
Terminology

Biological term	Description
Accommodation	The ability to change the focal length of the object by changing the convex shape of the lens to assist with focussing on a near or distant object
Astigmatism	Uneven curvature of the lens or cornea resulting in distorted images
Aqueous humour	The watery fluid that supports the cornea and the front chamber of the eye
Long-sightedness	Disorder of the eye where a person can see objects far away but not objects close by; this is caused by a lens that cannot become rounded enough to refract light, so the image falls behind the retina
Short-sightedness	Disorder of the eye where a person can see objects close by but not objects that are far away; this is caused by a lens that is too rounded, so the image falls short of the retina
Optic nerve	The nerve that carries impulses from the retina to the brain
Photoreceptors	Specialized receptors to receive the stimulus of light and convert it to an impulse. Photoreceptors in the retina of the eye are called rod and cone cells
Refraction	To bend light – refraction takes place when light passes through a lens that is bent by a **convex** [**()**] shape or a **concave** [**)(**] shape
Retina	Innermost membrane in the eye that contains photoreceptors
Stereoscopic vision	Also known as binocular vision - to see with **two** eyes, where each eye will produce a slightly different image of the same object and allows us to judge distance, depth and size of an object

Human response to the environment

The Ear



Outer

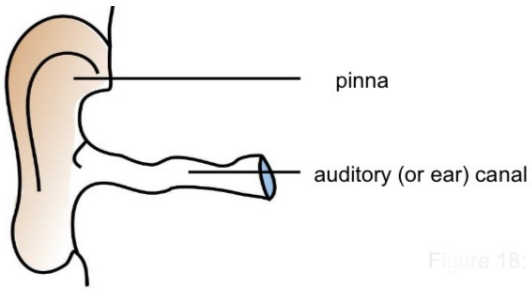
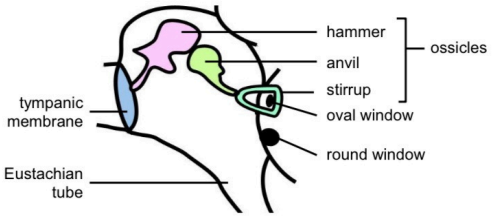
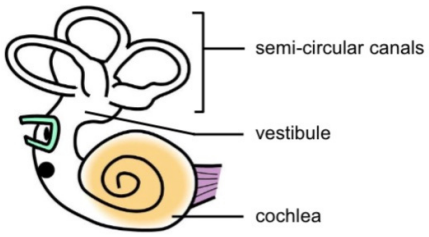


Figure 18:

Middle



Inner



pinna	
• cartilage flaps situated on the out-side of the ear	• direct sound waves into the auditory canal
auditory canal	
• tube which passes from the pinna to the tympanic membrane	• transmits sound waves to the tympanic membrane • has little hairs which prevent foreign bodies from entering the ear • has wax which prevents the tympanic membrane from drying out

tympanic membrane	
• thin membrane separating the inner ear from the middle ear	• sound waves moving in auditory canal cause it to vibrate • transmits sound waves to the middle ear

ossicles	

• three irregularly shaped bones:
  ○ hammer (malleus) – largest, connected to tympanic membrane
  ○ anvil (incus) – middle bone, joining the malleus to the stapes
  ○ stirrup (stapes) – smallest, connected to the round window
	• vibrations from the tympanic membrane are transmitted through the ossicles to the inner ear
	• serve to amplify the vibrations (make them larger)

oval window	
• membrane separating the middle ear from the inner ear	• transmits vibrations from the middle ear to the inner ear
round window	
• membrane situated below the oval window	• absorbs excess pressure waves from the inner ear – stop vibrations being echoed
Eustachian tube	
• thin tube connecting the middle ear to the back of the throat	• equalising pressure on both sides of the tympanic membrane

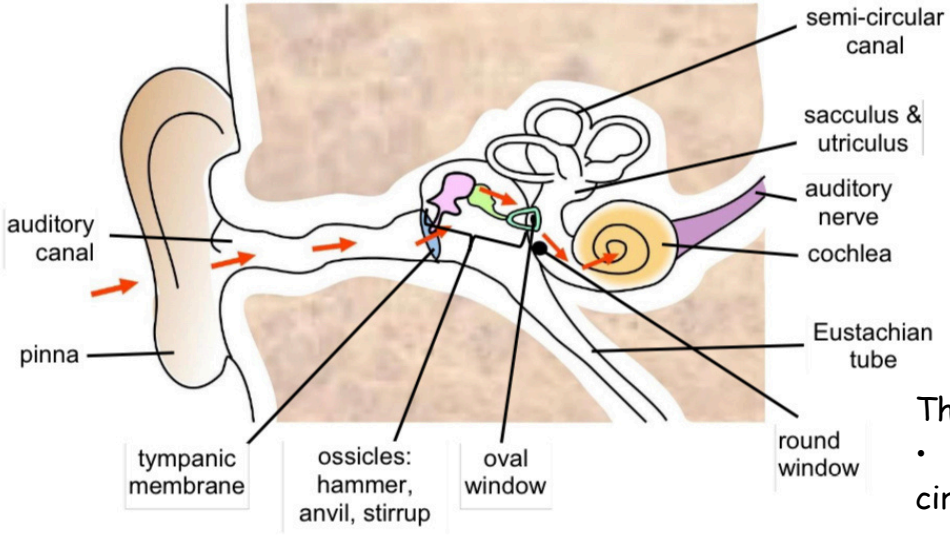
Structural adaptations	Functions
semi-circular canals	
• three semi-circular canals are arranged at right angles to each other • they are located above the vestibule • each canal has an enlarged area, called the ampulla, at one end • inside the ampulla are receptors (cristae)	• cristae detect changes in speed and direction and generate impulses sent to the cerebellum
vestibule	
• made up of two membranous sacs called the sacculus and utriculus (both filled with endolymph); inside each are receptors called maculae • maculae have tiny hair cells covered with a jelly-like substance and tiny calcium carbonate stones.	• receptors (maculae) detect changes in the position of the head with respect to gravity
cochlea	
• divided into three chambers • the upper and lower chambers are filled with perilymph • middle chamber is filled with endolymph, and contains the organ of Corti • organ of Corti contains tiny hairs embedded into a membrane	• organ of Corti is receptor responsible for interpreting sound • it converts the stimulus of sound into an impulse

Human response to the environment

Hearing & Balance

Hearing

- The pinna traps and directs sound waves into the auditory canal towards the tympanic membrane.
- The tympanic membrane vibrates as the sound waves strike against it.
- The vibrating tympanic membrane causes the ossicles to vibrate.
- The hammer, anvil and stirrup amplify and transmit the vibrations to the oval window.
- 'The oval window is smaller than the tympanic membrane. As a result, the pressure increases, causing the sound to be amplified.
- 'The vibrating oval window causes pressure waves to travel through the endolymph in the cochlea.
- 'The organ of Corti in the middle chamber of the cochlea is stimulated.
- 'The stimulus is converted into a nerve impulse which is transmitted to the auditory nerve.
- The auditory nerve transmits the impulse to the cerebrum for interpretation.
- The pressure waves in the cochlea are absorbed into the middle ear through the round window and exit the body via the Eustachian tube.



Balance

The sacculae and utriculae

- contain special receptors called maculae that are stimulated. o When the position of the head changes,
- the pull of gravity stimulates sensory hair cells in the maculae to generate impulses.
- The impulses generated from the maculae are sent to the cerebellum.
- The cerebellum sends impulses to the skeletal muscles to restore the balance.

Balance

The ampullae

- are situated at the end of semi-circular canals contain cristae.
- The three semi-circular canals are positioned in three different planes o and therefore, any sudden changes in the speed and direction of body movement,
- cause the endolymph to move in at least one of the semi-circular canals.
- The movement of endolymph stimulates
- the cristae to generate impulses which are sent to the cerebellum.
- The cerebellum sends impulses to the skeletal muscles to restore the balance.

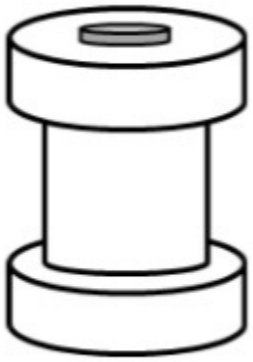
Human response to the environment

Hearing defects

Middle ear infections

Middle ear infection occurs when excess fluid builds up in the middle ear. It is caused by pathogens entering through the Eustachian tube. The fluid cannot drain through the Eustachian tube due to the infection from the pathogen which causes it to become inflamed.

<u>Treatment</u>:
- medication
- grommets are used for young children. A grommet is a draining tube which is put into the tympanic membrane through surgery which allows moisture from behind the tympanic membrane to drain out.



A grommet

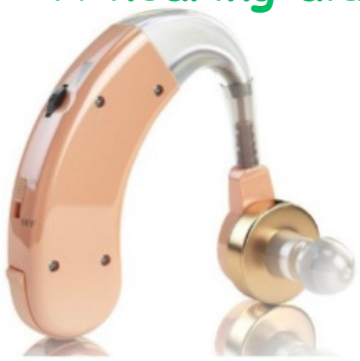
Deafness

Deafness refers to a total or partial hearing loss.
It may be caused by:
- injury to parts of the ear, nerves or parts of the brain responsible for hearing
- hardening of ear tissues such as the ossicles

<u>Treatment</u>:
- hearing aids
- cochlear implants

Does the job of the cochlear - hence the name.

A hearing aid



Amplifies sound as a result of poor functioning of the ossicles

A cochlear implant

The Ear

Terminology

Biological term	Description
Auditory Canal	The open passage through which sound waves travel to the middle ear.
Auditory Nerve	Bundle of nerve cells that carry signals from the sensory fibres to the brain.
Cochlea	Coiled, fluid-filled structure of the inner ear that contains hair cells called cilia. Cilia sway in response to sound waves, transmitting signals toward the brain.
Eardrum/Tympanum	A taut, circular piece of skin that vibrates when hit by sound waves.
Eustachian Tube	The passageway that connects the ear to the back of the nose to maintain equal air pressure on both sides of the eardrum.
Grommets	Small tubes placed in the tympanum to drain moisture from the middle ear
Mechanoreceptors	The Organs of Corti are receptors located in the cochlea of the ear, which are stimulated by sound waves and convert the sound waves into impulses.
Ossicles	Three little bones called the hammer, anvil and stirrup located in the middle ear and that function to amplify sound.
Otis media	Inflammation and infection of the middle ear which causes pressure on the eardrum.
Pinna	The outer portion of the external ear: sound travels through the outer ear to the ear canal.
Semi-circular Canals	Fluid-filled structures in the inner ear that detect movement and function as balance organs.