

The nervous system and the eye

Revision notes · The central nervous system, nerve impulses, synapses, the reflex arc, and the structure and function of the eye.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

The nervous system and the eye Spec 2.87-2.92

The central nervous system and nerve impulses Spec 2.87, 2.88

The nervous system lets you react to your surroundings and coordinate your behaviour. The **central nervous system (CNS)** is made up of the **brain and spinal cord**. It is linked to the sense organs (such as the eye and the skin) by **nerves**.

When a **receptor** in a sense organ is stimulated, it sends electrical impulses along neurones in the nerves into the CNS. The CNS sends electrical impulses out along nerves to **effectors**. Effectors are muscles (which contract) or glands (which secrete). Impulses travel quickly, so the response is rapid.

1. Stimulus (a change in the surroundings)
2. Receptor in a sense organ is stimulated
3. Electrical impulses travel along nerves into the CNS (brain and spinal cord)
4. Electrical impulses travel out along nerves to an effector
5. Effector (muscle or gland) produces the response

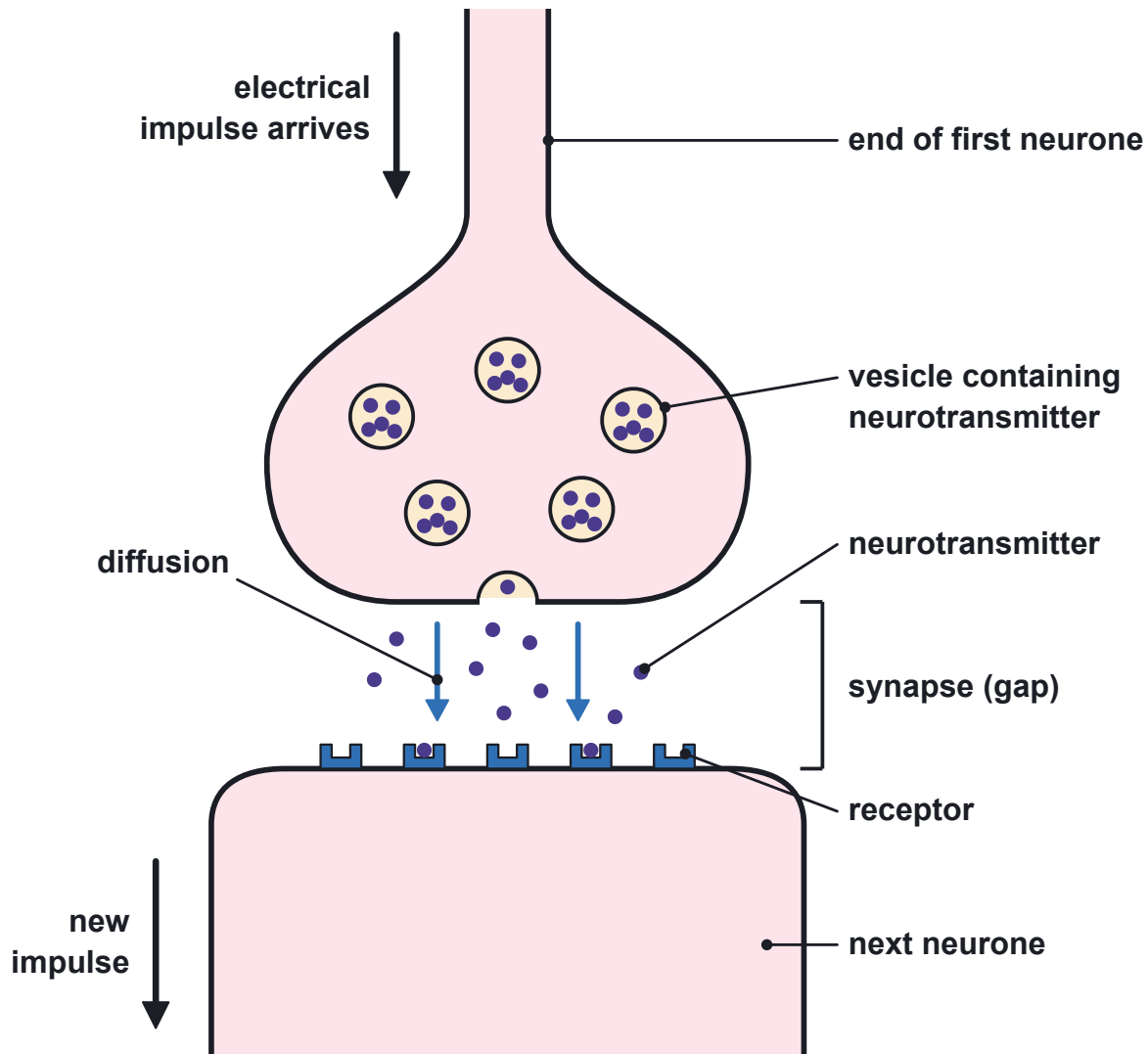
Parts of the nervous pathway	
Part	Job
Receptors	Detect a stimulus and start electrical impulses
Nerves	Bundles of neurones that carry impulses to and from the CNS
CNS (brain and spinal cord)	Receives impulses and coordinates the response
Effectors	Muscles or glands that carry out the response

Exam tip: The CNS is the brain and spinal cord only. Nerves are not part of the CNS; they link it to the sense organs and effectors.

Synapses and neurotransmitters Spec 2.89

A **synapse** is a gap between two neurones. The electrical impulse cannot cross the gap, so a chemical is used instead.

1. An electrical impulse arrives at the end of the first neurone.
2. The neurone releases a chemical called a **neurotransmitter** into the synapse.
3. The neurotransmitter **diffuses** across the gap.
4. It binds to receptors on the membrane of the next neurone.
5. This triggers a new electrical impulse in the next neurone.



At a synapse the neurotransmitter diffuses across the gap and binds to receptors on the next neurone.

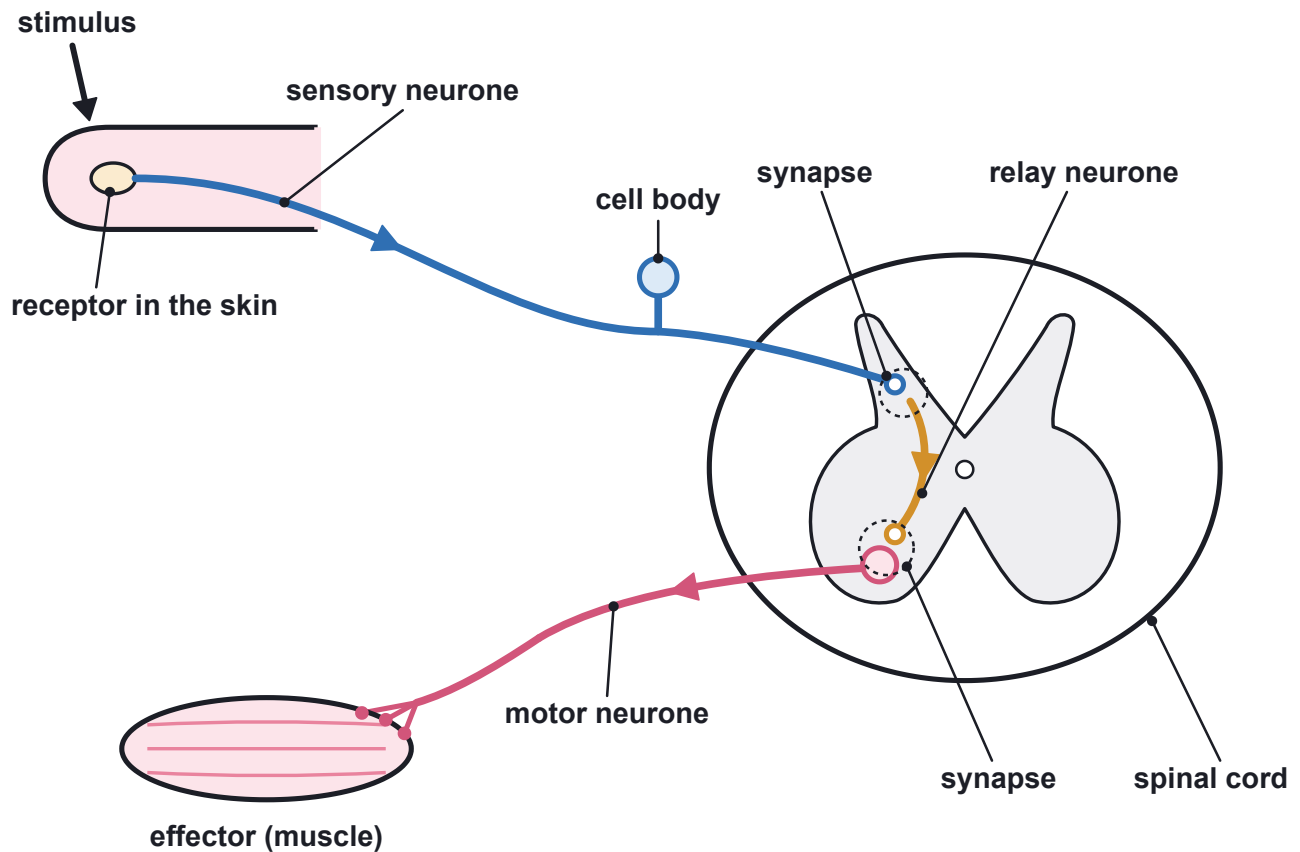
Common mistake: The impulse itself does not cross the synapse. A neurotransmitter diffuses across and starts a new impulse in the next neurone.

The reflex arc Spec 2.90

A **reflex** is a fast, automatic response to a stimulus that does not involve conscious thought. The pathway it follows is a **reflex arc**. Reflexes protect the body from harm. An example is pulling your finger away from a hot object.

1. A receptor in the skin of the finger detects the heat (the stimulus).
2. A **sensory neurone** carries impulses to the spinal cord (CNS).
3. At a synapse the impulses pass to a **relay neurone** in the spinal cord.
4. At another synapse the impulses pass to a **motor neurone**.
5. The motor neurone carries the impulses to an effector, a muscle in the arm.
6. The muscle contracts and the finger is pulled away.

The impulses do not have to reach the conscious part of the brain before the response happens, so the reflex is very fast.



A reflex arc: receptor, **sensory neurone**, **relay neurone**, **motor neurone**, effector. Impulses cross a **synapse** between each pair of neurones.

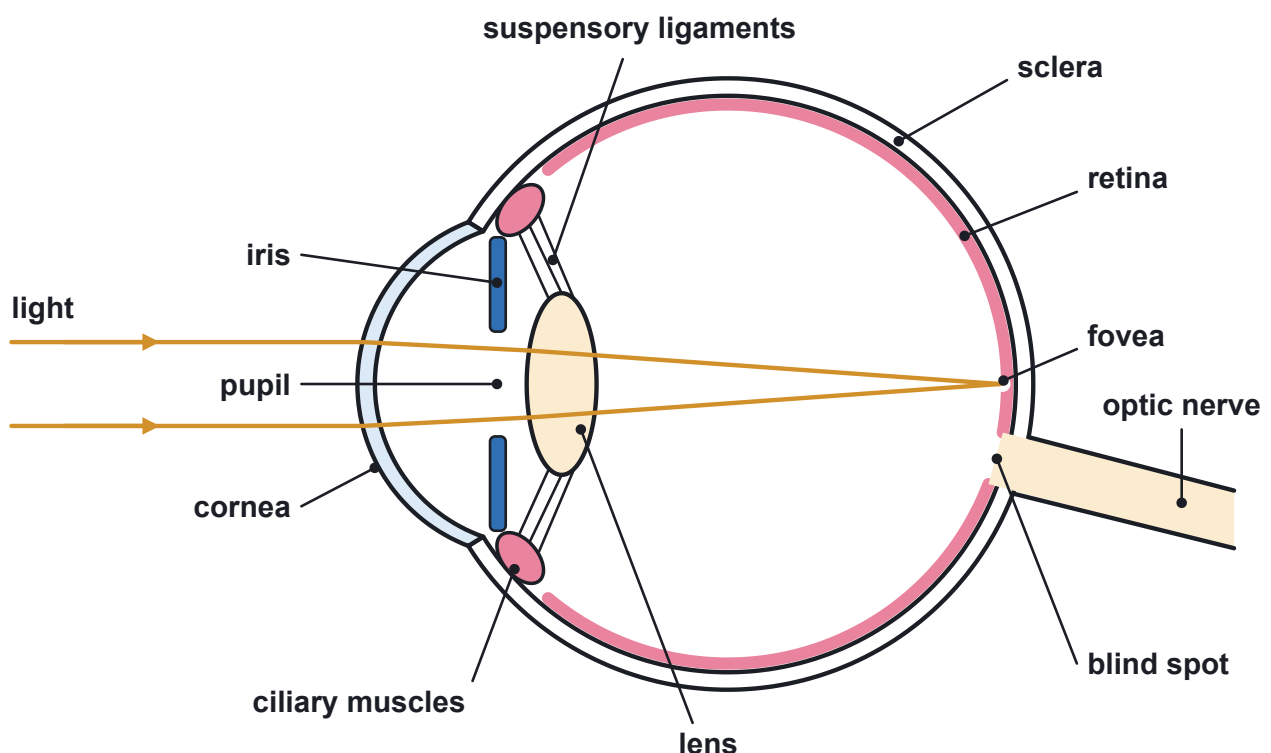
Exam tip: Write the pathway in order and name each neurone: sensory, relay, motor. The effector is the muscle, not the motor neurone.

Structure and function of the eye Spec 2.91

The eye is a sense organ and acts as a **receptor**. It detects light and sends impulses to the brain.

Parts of the eye

Part	Function
Sclera	Tough white outer layer that protects the eye
Cornea	Transparent front surface. It refracts (bends) light as it enters the eye
Iris	Ring of muscle that changes the size of the pupil, so controls how much light enters the eye
Pupil	The hole in the middle of the iris that lets light through
Lens	Refracts light to focus it on the retina
Ciliary muscles	Ring of muscle around the lens. Contracts or relaxes to change the shape of the lens
Suspensory ligaments	Hold the lens in place and connect it to the ciliary muscles
Retina	Contains the light receptor cells (rods and cones)
Fovea	Part of the retina with the most cones. Gives the sharpest, most detailed vision
Blind spot	Where the optic nerve leaves the eye. It has no receptor cells, so no light is detected there
Optic nerve	Carries impulses from the retina to the brain



The structure of the eye. The **cornea** and **lens** refract light so it focuses on the retina at the **fovea**.

Rods and cones

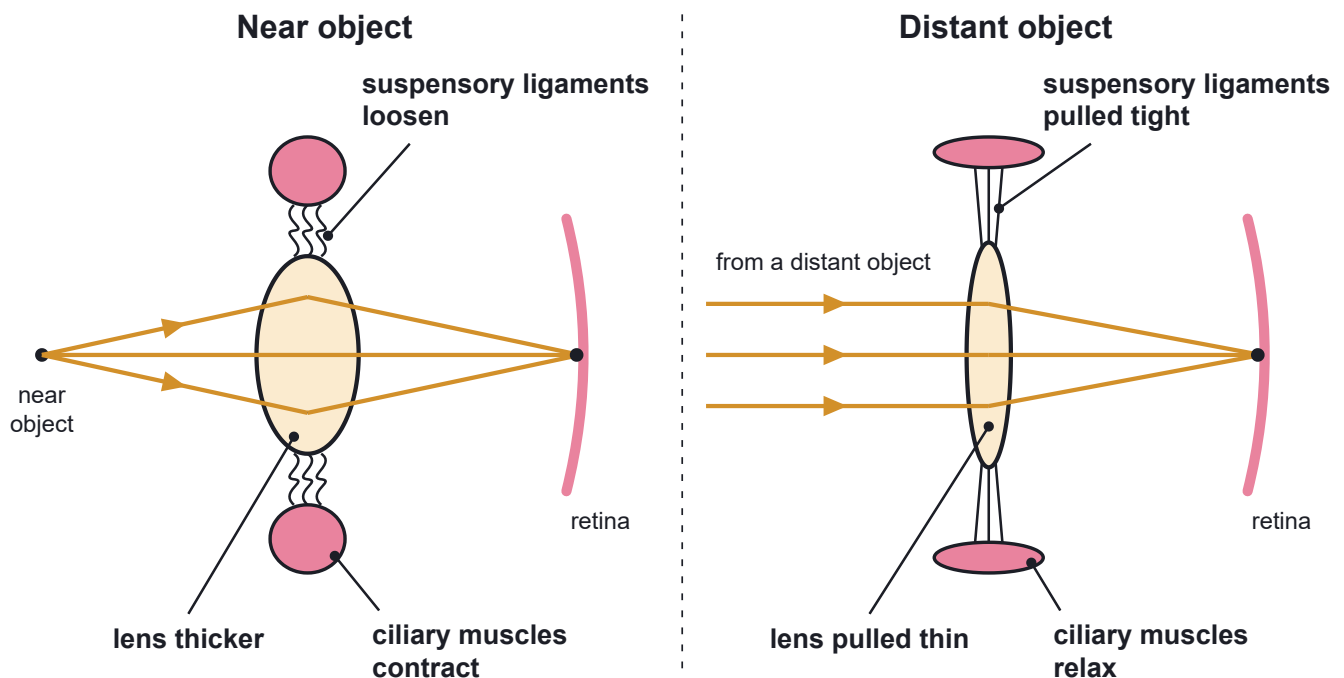
The retina has two types of receptor cell. **Rod cells** are sensitive to dim light but do not detect colour. **Cone cells** detect colour and work in bright light.

Exam tip: Give each part with its job and a reason, for example 'the cornea refracts light', not just 'the cornea is at the front'.

Focusing and the pupil reflex Spec 2.92

The eye can focus on both near and distant objects. The **lens changes shape** to do this. The **ciliary muscles** (a ring of muscle around the lens) and the **suspensory ligaments** (which hold the lens in place) control the lens shape.

Focusing on near and distant objects		
	Near object	Distant object
Ciliary muscles	Contract	Relax
Suspensory ligaments	Loosen	Pulled tight
Lens shape	Thicker (more curved)	Pulled thin (flatter)
Refraction of light	Light rays refracted more	Light rays refracted less



Near object: **muscles contract, ligaments loosen, lens thicker**. Distant object: muscles relax, ligaments tight, lens thin.

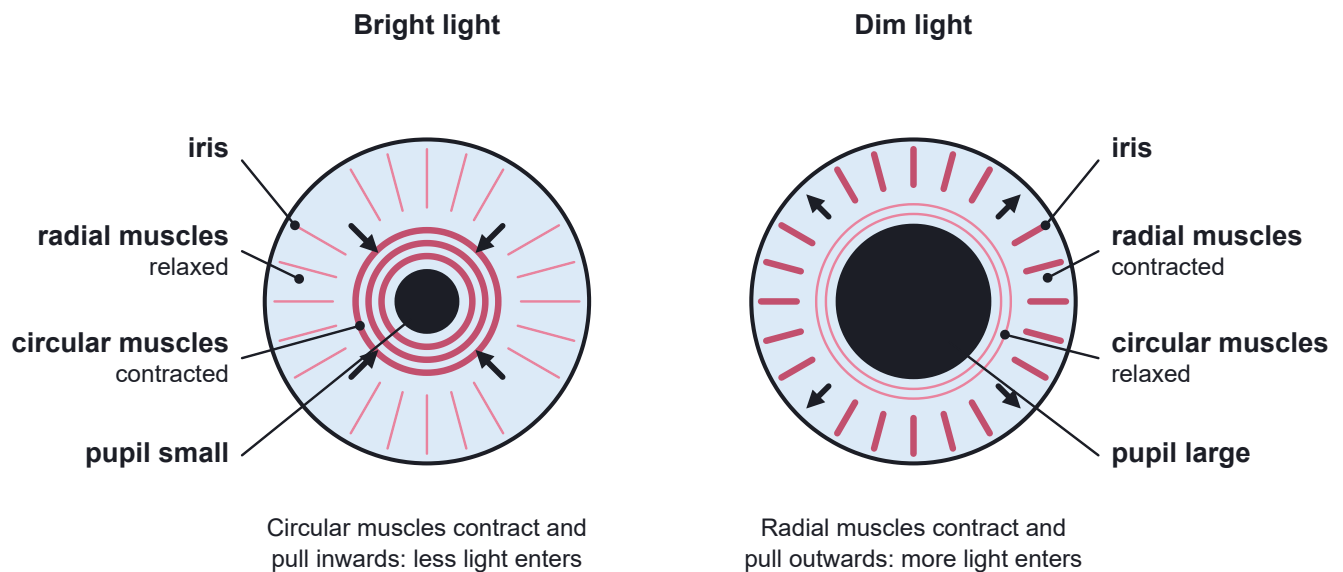
Common mistake: For a near object the ciliary muscles contract and the ligaments go slack. Many students reverse this. Remember: contracted muscle, loose ligaments, fat lens.

Changes in light intensity: the pupil reflex

The size of the pupil changes automatically in response to light intensity. This is a reflex, so it is fast and protects the retina. The iris has two sets of muscle: **circular muscles** (in rings around the pupil) and **radial muscles** (running out from the pupil like spokes).

The pupil reflex

	Bright light	Dim light
Circular muscles	Contract	Relax
Radial muscles	Relax	Contract
Pupil	Gets smaller (constricts)	Gets larger (dilates)
Effect	Less light enters, so the retina is protected from damage	More light enters, so you can see better



The pupil reflex. Bright light: **circular muscles contract**, pupil smaller. Dim light: **radial muscles contract**, pupil larger.

Exam tip: Name the muscles and say what each does. 'Circular muscles contract' makes the pupil smaller; 'radial muscles contract' makes it larger.

Quick check

1. What two organs make up the central nervous system?
2. What carries the message across a synapse?
3. Name the three types of neurone in a reflex arc, in order.
4. Which part of the eye contains the light receptors?
5. In bright light, do the circular muscles of the iris contract or relax?

Quick check answers

The nervous system and the eye

1. The brain and the spinal cord.
2. A neurotransmitter, which diffuses across the gap.
3. Sensory neurone, relay neurone, motor neurone.
4. The retina.
5. They contract, making the pupil smaller.