WJEC (Wales) Biology GCSE

Topic 2.5: Regulation and Response

Notes

('Higher Tier only' in **bold**)

The nervous system

Structure of the nervous system

The **nervous system** is made up of the **brain** and **spinal cord** (**central nervous system**, CNS) along with specialised **nerves** that carry information as impulses into and out of the CNS.

The nervous system controls movement by sending electrical signals (**nerve impulses**) along a network of specialised nerve cells known as **neurones** (the **'functional units'** of the nervous system). This allows an organism to rapidly react to environmental and internal changes.

There are three types of neurone:

- **Sensory** neurone - carries impulses from **receptors** (sense organs) to the **CNS.**
- **Relay** neurone - carries impulses from **sensory** neurones to **motor** neurones in the CNS.
- **Motor** neurone - carries impulses from the **CNS** to **effectors** (muscles and glands).

A synapse is a small gap between neurones across which a nerve impulse is transmitted via neurotransmitters.

Sense organs

Sense organs are a group of receptor cells that detect specific stimuli (environmental and internal changes e.g. temperature, sound) and send information to the CNS along neurones. The eye is an example of a sense organ that responds to light.

Reflex actions

A reflex is an automatic response to a stimulus by the body. It is involuntary (does not involve the conscious part of the brain) and serves as a protective mechanism. Some types of reflex are outlined below:

- Withdrawal reflex - pulling away, initiated when touching a hot object to prevent burns.
- Pupil reflex - pupils constrict to prevent damage to the eye by bright light.
- Blink reflex - protects the eyes from foreign bodies.

A reflex arc is the nerve pathway involved in a reflex action. It requires:

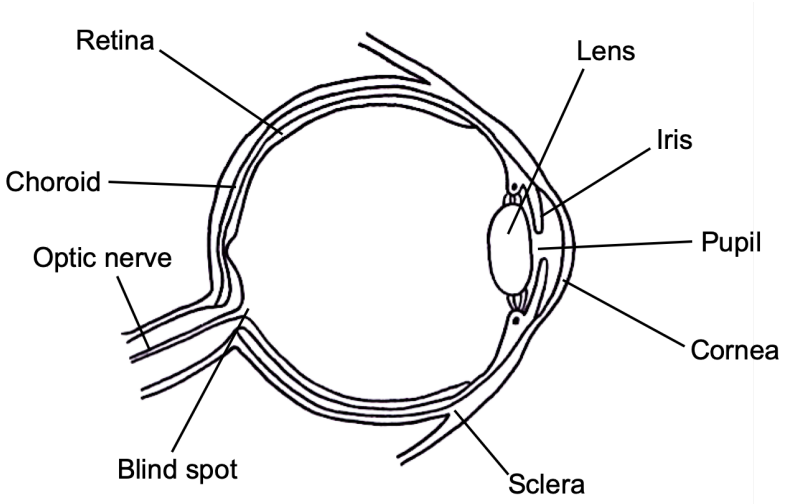
- **Stimulus**
- **Receptor**
- **Coordinator**
- **Effector**
- **Response**

The coordinator coordinates information from the receptors and transmits impulses to the effectors.

Reflex arc pathway: stimulus → receptor → sensory neurone → relay neurone → motor neurone → effector → response

The eye

Structure of the eye



The structure and function of each part of the eye is described below:

Part	Structure	Function
Lens	Transparent bi-convex structure. Flexible (changes shape via accommodation)	Refracts light, focusing it onto the retina
Pupil	Hole in the centre of the iris	Allows light to enter the eye
Iris	Pigmented ring of circular and radial muscles	Controls the size of the pupil to alter how much light enters the eye
Cornea	Transparent outer covering	Refracts light entering the eye
Retina	Light-sensitive layer containing photoreceptors	Converts light energy into neural signals which are sent to the brain via the optic nerve
Choroid	Black pigmented layer	Absorbs light, preventing internal reflection
Sclera	Opaque, white protective outer layer. Transparent at the front.	Maintains eyeball shape
Optic nerve	Located at the back of the eye	Transmits nerve impulses to the brain from the retina

The blind spot is the point at which the optic nerve leaves the eye. No photoreceptors cells are located here.

Homeostasis

Homeostasis is the maintenance of a stable internal environment in the body despite fluctuations in internal and external conditions. It is important to ensure optimum conditions for enzymes and cellular processes in the body.

Temperature, blood glucose concentration and water levels must be maintained.

Hormones

A hormone is a cell signalling molecule produced by the endocrine glands and released into the blood. It travels to a target organ and binds, initiating a response.

Control of blood glucose concentration

Blood glucose concentration must be controlled:

- If blood glucose concentration rises too high the body risks dehydration.
- If blood glucose concentration becomes too low the rate of cellular respiration decreases.

Blood glucose concentration is controlled by the hormones insulin and glucagon which are secreted by the pancreas.

Hormone	Effect
Insulin	• Causes liver and muscle cells to increase their uptake of glucose. • Glucose is converted into glycogen, a storage molecule.
Glucagon	• Causes the breakdown of glycogen to glucose in the liver. • Glucose is released into the blood.

Negative feedback

Negative feedback is a corrective mechanism that allows only small fluctuations around a set point. An example of this is the control of blood glucose concentration.

When blood glucose concentration increases above a set point…

- **Pancreas secretes insulin and stops producing glucagon.**
- **Liver cells convert glucose to glycogen which is stored.**

- **Blood glucose concentration decreases, returning to normal level.**

When blood glucose concentration decreases below a set point…

- **Pancreas secretes glucagon and stops producing insulin.**
- **Liver cells convert glycogen into glucose which is released into the blood.**
- **Blood glucose concentration increases, returning to normal level.**

Diabetes

Diabetes is a condition where the homeostatic control of blood glucose levels stops working. There are two types of diabetes: type 1 and type 2.

Type of diabetes	Cause	Treatment
Type 1	Immune system attacks and destroys insulin-producing cells ∴ pancreas does not produce enough insulin.	• Daily insulin injections at meal times. • Managing diet (limiting intake of refined sugars). • Regularly testing blood glucose levels.
Type 2	Person develops insulin resistance (links to obesity).	• Managing diet. • Regular exercise. • Drugs e.g. metformin.

Control of body temperature

Body temperature must be controlled because...

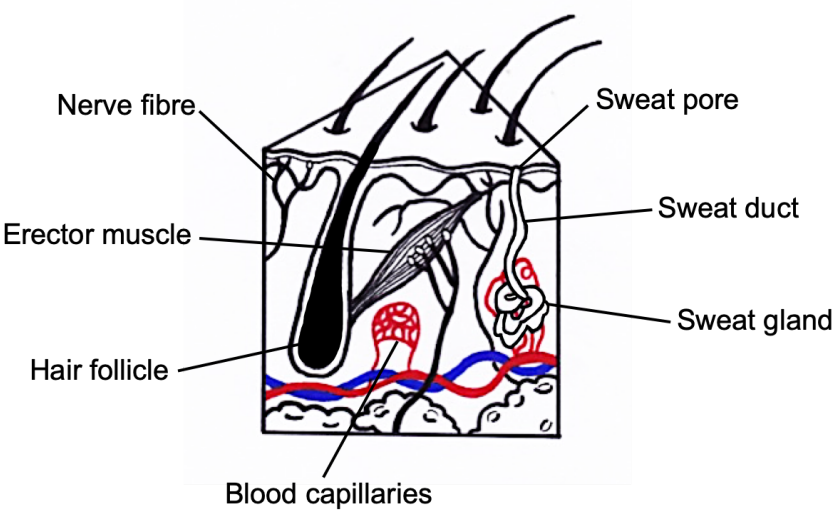
- Enzymes work best at their optimum temperature (37°C).
- Deviations from the optimum decrease the rate of enzyme-controlled reactions.

The skin is the main organ responsible for the control of body temperature. The structure of a section of skin is shown below.

The control of body temperature is an example of negative feedback.

Temperature increases above 37°C	Temperature decreases below 37°C
Vasodilation: Dilation of blood vessels near	Vasoconstriction: Constriction of blood vessels

skin surface. Blood flows closer to the skin surface ∴ greater heat loss to surroundings.	near skin surface. Less blood flows close to skin surface ∴ reduced heat loss to surroundings.
Sweating: Heat energy used to evaporate sweat. Increased heat transfer from skin to environment ∴ body temperature decreases.	Little sweat is produced.
Erector muscles relax: Hairs lie flat.	Erector muscles contract: Hairs stand on end creating pockets of air between hairs and a layer of insulation.
No shivering.	Shivering: Involuntary contraction of muscles generates heat energy from respiration.



Lifestyle choices

Some conditions are affected by lifestyle choices:

- Obesity increases the risk of type 2 diabetes.
- Drugs affect chemical processes within the body and can produce damaging side effects.
- Alcohol decreases reaction times and causes liver damage, cardiovascular disease etc.

Plant responses

Plant tropisms are the growth responses of a plant to stimuli. A positive tropism is the growth of a plant towards a stimulus whereas a negative tropism is the growth of a plant away from a stimulus. Plant tropisms are controlled by the hormone auxin, which stimulates growth in plant shoots and inhibits growth in plant roots.

Two types of plant tropisms are phototropism and gravitropism.

Phototropism

Phototropism is a plant's growth response towards light.

- Plant shoots are positively phototropic as they grow towards the light.
- Plant roots are negatively phototropic as they grow away from the light.

Gravitropism

Gravitropism is a plant's growth response to gravity.

- Plant shoots are negatively gravitropic as they grow away from gravity.
- Plant roots are positively gravitropic as they grow towards gravity.

Importance

Plant tropisms increase a plant's chance of survival:

- They enable plants to respond to their environment.
- Shoot growth towards the light maximises light absorption.
- Root growth downwards increases the uptake of water and minerals from the soil and enables anchorage of the plant body to the ground.