Homeostasis and regulatory mechanisms

VCE Biology Unit 3
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Cellular Environments

- The internal environment of an organism is both the cytosol within cells and the watery fluid called extracellular fluid that bathes all tissues.
- The external environment of an organism is clearly the environment outside of the body of that organism, but this includes the interior of the digestive tract, respiratory tract and uro-genital tract.
Homeostasis

- All organisms attempt to maintain a relatively stable internal environment; that is, all organisms attempt to maintain homeostasis with varying degrees of success.
Homeostasis

- Living organisms can survive, grow and reproduce only in external environments that provide adequate levels of nutrients, water, oxygen and carbon dioxide, and suitable physical conditions such as light and temperature.

- Many organisms can adapt to changing external environments, others are unable to and can be damaged or killed when conditions change.
Homeostasis

- Biochemical reactions in living cells can occur only when pH, various salts and nutrients, and physical conditions are within certain limits.
- Higher evolved multi-cellular organisms are more able to regulate their internal environment as they usually develop a protective outer layer and have specialised cells.
Homeostasis

- Vertebrates are able to precisely regulate the chemical composition and solute concentration of their internal environment. Mammals and birds are also able to regulate their body temperature.

- Many fish share our ability to regulate our water and solute concentrations.
Homeostatic Mechanisms

- Stimulus-response model
  - A change in the environment is received by a receptor and the organism interprets that change and responds in a way to protect the organism.
Homeostatic Mechanisms

- Negative feedback systems
  - The negative feedback system is a form of the stimulus response model that acts to restore the original state.
Homeostatic Mechanisms

- Positive feedback systems
  - Positive feedback systems are also examples of the stimulus response model, however, the effect is to reinforce or increase the change rather than to restore homeostasis.
The nervous system is made up of a series of receptors, nerve axons and effectors. It is able to receive information from the external and internal environment, send that information to the central nervous system for interpretation and transmit that decision to effectors to respond to the stimulus. Nerve responses are fast but short lived.
The Endocrine system consists of a number of glands and receptor organs.

Changes in the internal environment are detected which cause the glands to release hormones into the blood system. The hormones travel to certain effector organs and cause a response to the change.

Hormones are slow moving but the effect is generally felt for a period of time.
Homeostasis in mammals and birds

- Homeostasis is at its most developed in mammals and birds and is achieved by the integrated control of cellular processes, organ systems and behaviour.
Homeostasis in mammals and birds

- A well studied example is the maintenance of blood glucose levels.
  - Digestive system
  - Regulatory role of the liver
  - Regulate blood glucose level
Plant Regulation

- Plants are unable to regulate their internal environments precisely as animals.
- However, they do need to have water, oxygen and carbon dioxide available in sufficient quantity for photosynthesis and cellular respiration to occur.
Plant Regulation

- The stomata (an opening on the underside of leaves surrounded by a pair of guard cells) is used to regulate the movement of water, carbon dioxide and oxygen between the external and internal environment.

- Guard Cells are used to open and close the stomata:
  - They are joined at each end
  - The walls nearest to the stomata are thickest
  - Bands of inelastic cellulose fibres run around each cell
  - As water enters the guard cell it swells and becomes turgid opening the stomata.