Chapter: 8

Thermoregulation:

"Maintenance of internal temperature within a range that allow cells to function efficiently."

Need:

To keep the enzymes of the body working properly.

Classification of Animals:

Animals can be classified on the basis of ability to maintain constant body temperature into:

1) Poikilotherms:

→ unable to maintain their body temperature within narrow limits using physiological mechanism.

Example: non-vertebrates, fishes, amphibian and reptiles

2) Homeotherms:

→ maintain a fairly constant body temperature by using physiological mechanism

Example: Birds and Mammals

Animals are also classified on the basis of source of body heat:

1) Ectotherms
2) Endotherms

1) Ectotherms:
- Animals produce metabolic heat at low level and that is also exchanged quickly with environment.
- They rely more on heat derived from the environment to raise their body temperature.

Examples: most invertebrates, fishes, amphibians and reptiles.

2) Endotherms:
- Animals produce their own body heat through heat production as by product during metabolism in muscles or by the action of hormones that increases metabolic rate.

Examples: Birds and Mammals

Thermoregulatory Strategies in Man:

- Hypothalamus is the thermoregulatory centre (thermostat) that detect the change in temperature and produces behavioural responses and physiological responses.

- Physiological responses to heat:

-) Body produces two main physiological responses on the detection of high temperature by hypothalamus:

1) Vasodilation
2) Sweating

1) Vasodilation:
- During vasodilation muscles in the wall of arterioles relaxes, that causes the dilation of arterioles near the skin.
- The arterioles allow greater volume of blood to flow through the capillaries to increase heat loss.

2) Sweating:
Sweating is a cooling effect because it absorbs the heat from the body to regulate the internal body temperature.
Factors:
Efficiency of sweating depends on humidity.
- In dry air, human can tolerate temperature of 65°C for several hours.
- In humid air when the sweat cannot evaporate, temperature of only 56°C cause overheating.

Physiological responses to cold:
Body produces four main physiological responses on the detection of low temperature.
1) Vasoconstriction
2) Shivering
3) Piloerection
4) Increased metabolic rate

1) Vasoconstriction:
During vasoconstriction, muscles in the wall of arteries contract that causes the contraction of arterioles near the skin.
- The arterioles allow less volume of blood to flow through capillaries to decrease heat loss.

2) Shivering:
Shivering is the contraction and relaxation of muscles that gives out four or five times much heat as the resting muscle.

3) Piloerection:
It means the erection of hairs
In most mammals, piloerection makes the fur thicker that traps more air to provide extra insulation
In humans, the erector pilli muscles pull the tiny hair upright and creates the goosebumps.

4) Increased Metabolic rate:
The body produces adrenaline in response to the cold to increase the metabolic rate and heat production

Homeostasis:
A process by which the organisms keep internal temperature constant despite the changes in the external environment

Organs of Human involved in Homeostasis:
- Lungs
- Kidney
- Liver

Types of Environment:
Animals have two environment in their life:

1) External Environment.
The environment in which the organisms live
E.g: Atmosphere, marine water, fresh water

2) Internal Environment:
The environment in which tissue lives.
E.g: interstitial fluid, lymph, plasma

Components of Homeostatic
It has three main components:
1) Receptor
2) Control Centre
3) Effector

1) Receptor:
- Receptor receives the information of changing in external or internal environment and respond it.
- It includes mechano-receptors and thermo-receptors

2) Control Centre:
- It receives and processes the information from the receptor.
- It includes the renin/angiotensin system (RA)

3) Effector:
Effectors respond to the control centre to maintain homeostasis by either opposing or enhancing the stimulus.

Example:

During thermoregulation, thermo-receptors in the skin send information to the brain which signals the effector to the blood vessels and sweat glands.

Control of Homeostatic Mechanism:

Homeostasis is controlled by nervous and endocrine system in mammals. Feedback mechanisms necessary for the life to occur.

Feedback:

A Feedback mechanism is a regulatory system that works to return the body to its normal internal state.

Negative Feedback Mechanism:

In negative feedback loop the change in a given direction is opposed by the end product.

- Negative feedback mechanism may either increase or decrease the stimulus but the stimulus is not allowed to contine as it did before.
- In other words, if a level is too high the body tends to lower it and vice versa.

Example:

Maintenance of blood glucose level

Maintenance of blood calcium level (detail from book pg 161)

Positive Feedback Mechanism:
In positive feedback, the end product increases or speeds up the production.
Example:
Uterine contraction during child birth
Clotting of blood (detail from book)

Osmoregulation:

"Maintenance of water and solute concentration in the body."
→Animals may be osmoregulator or osmoconformers.

Osmoconformers:
Animals that change the osmotic concentration of the body fluid according to the type of surrounding medium.
→ They are isotonic to their external environment
Example: Marine invertebrates, some fresh water invertebrates, some marine vertebrates like myxine (hagg fishes) and elasmobranches (sharks and rays)

Osmoregulators:
Animals that can maintain internal osmotic concentration different from the surrounding medium
→ They are hypertonic / hypotonic to their external environment.
Example: All fresh water animals, most marine invertebrates

Problems faced by Osmoregulators

Fresh-Water Animals:

-They live in hypotonic environment therefore water constantly enters the body and also forces the deficiency of salts.

Marine Water Animals:

-They live in hypertonic environment and they faces the problem of losing water to the environment and have excess of salts in the body due to intake of salt water.

Terristrial animals:

-They also live in hypertonic environment they faces the major problem of evaporation of water that leads to dehydration.

Adaptations Faced by Osmoregulators:

Fresh Water Animals:

-Almost all the freshwater animals are osmoregulators

-They deal with the problems by following ways:

1) They produce large volume of diluted urine
2) These kidney reabsorbs the salts that are required salts are also obtained from the food they eat
3) They have special salt cells called ionocytes in amphibian skins and gills of the fishes to actively transport salts from their environment

meow

Marine-Water Animals:

- In order to replace the water loss, these fishes usually drink large amount of water.
- Excess of salts in the body like Na^+, Cl^- and K^+ are removed by the gills while divalent ions such as Mg^{+2} and Ca^{+2} are excreted by the kidney.
- Some fishes have rectal glands present in the walls of rectum that removes extra salts into the digestive tract which are then eliminated out of the body.

Terrestrial Animals:

- Arthopods are the successful groups of land animals among invertebrates and vertebrates.
- Arthopods have chitinous exoskeleton and vertebrates have dead keratinized skin to reduce water loss from their bodies.
- Desert animals can tolerate strong degree of dehydration by special metabolic and behavioural adaptation called anhydrobiosis.