Role of cell signalling in regulation of homeostasis

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Introduction

What is Homeostasis?

Homeostasis is the ability to maintain a constant internal environment in response to environmental changes.

Homeostasis is a ability to maintain relatively stable internal conditions even though there is continuous change in outside world.

The term homeostasis is derived from the two Greek wordshomeoandstasis. Homeo which means unchanging and stasis means standing. It means staying the same. Homeostasis is the maintainance of the internal environment within narrow limits. Skin, kidney, liver, endocrine system, nervous system, and sensory system all play a part in maintaining the internal environment within narrow limits

There is no specific organ which controls homeostasis except brain. The nervous and endocrine systems control homeostasis with various organs and organ systems in the body through feedback mechanisms.

Examples of homeostasis in the body include temperature control, pH balance, water and electrolyte balance, blood pressure, and respiration

Homeostasis maintain a constant internal environment in the body. Monitoring and adjustments are required to maintain a constant internal environment in the body. This adjustment of physiological systems in the body is called homeostatic regulation.

Homeostatic control mechanisms include three components : 1) Receptor, 2) Control center and 3) Effector.

The receptor receives information from the something changing in the environment. Receptor monitors the environment and responds to changes (stimuli). The control center determines the set point at which the variable is maintained. Effector responds to stimuli. This process continuously works to maintain homeostasis.

e. g. In regulating body temperature Receptor – Skin, control center – Brain, Effector – Blood vessels and sweat glands in the skin.

Since homeostasis is an attempt to maintain the internal conditions of an environment by limiting fluctuations, it must involve a series of negative feedback loops

- Thermoregulation andHOMEOSTASIS

Temperature regulation is an excellent example of homeostasis. It refers to the maintenance of constancy of the bodily state within narrow limits by a dynamic equilibrium.

CLASSIFICATION OF ANIMALS BASED ON THERMOREGULATION

Based on thermoregulation, animals are classified into two major groups. They are as follows:

1. POIKILOTHERMIC ANIMALS OR THERMO CONFORMERS

In many animals the body temperature changes according to the fluctuation of environmental temperature. These animals are called POIKILOTHERMIC

ANIMALS. When the environment is cold, their blood also becomes cold. Hence they are called cold blooded animals. They cannot regulate their body temperature by metabolism; but they gain temperature from the environment. Hence they are also called ECTOTHERMIC animals. eg. All animals except birds and mammals.

2. HOMEOTHERMIC ANIMALS OR THERMO REGULATORS

In some animals the body temperature remains constant and it is independent of environmental temperature. These animals are called HOMEOTHERMIC ANIMALS. When the environment is cold the blood of these animals are will be at a higher temperature. Hence these animals are also called warm blooded animals. They can regulate their body temperature by generating heat through metabolic activities. Hence they are also called endotnermic animals. Eg. Birds and mammals.

Based on the source of body heat , animals are classified into three types , namely ectotherms, endotherms and heterotherms.

ECTOTHERMS

Ectotherms are animals depending on their surrounding for the source of the body heat. Eg. All animals except birds and mammals. The ectotherms have the following salient features:

1. In ectotherms, the body temperature passively adjusts with the surrounding temperature.
2. They have low rates of metabolic heat production

3. They have high thermal conductances and are poorly insulated. As a result the heat derived from metabolic processes is quickly lost to the surroundings.
4. The high thermal conductance allows the ectotherms to absorb heat readily from their surroundings.
5. They regulate their body temperature by behavioural temperature regulation.

ENDOTHERMS

Endotherms are animals which generate heat on their own body. Eg. Birds, mammals, a few lower vertebrates and some insects. The endotherms have the following salient features

1. The endotherms maintain their body temperature well above the ambient(= surrounding) temperature in cold climates.
2. They have high rates of metabolic heat production.
3. The metabolic rate of an endotherm at rest is at least 5 times that of an endotherm of equal size.

They are well insulated with feathers and fur.

4. They regulate their body temperature by thermogenesis.

HETEROTHERMS

Heterotherm behave like ectotherms and endotherms. Like endotherms they gemerate body heat. Like ectotherm they can not maintain the body temperature within narrow range. Many flying insects, tunas, mako sharks, pythons, Echidna, camel, etc.

Positive and Negative Feedback

When a change of variable occurs, there are two main types of feedback to which the system reacts:

- Negative feedbackis a reaction in which the system responds in such a way that to reverse the direction of change. This keep things constant and allows the maintenance of homeostasis.
- For ex. when the concentration of CO_2 in the human body increases, the signals reach to lungs to increase their activity and expel more CO_2.
- In thermoregulation, when rise in body temperature, receptors in the skin and the control center hypothalamus in brain sense a change, which in turn effects the correct response, in this case body temperature decreases.
- In a human, if the body temperature exceeds the set point of 37°C, sensors in a part of the brain detect the change. Through integrating center these sensors stimulate effectors (including sweat glands) that lower the temperature. Effector produces a response to stimuli and decrease in body temperture and because of this regulation is in a negative or in reverse direction, this type of control system is known as a negative feedback loop
- Positive feedback–a response is to amplify the change in the variable. This has a destabilizing effect, so does not result in homeostasis. Positive feedback is less common in naturally occurring systems than negative feedback, but it has its applications.

- For example, in nerves, a threshold electric potential triggers the generation of a much larger action potential. Blood clotting in which the platelets process mechanisms to transform blood liquid to solidify is an example of positive feedback loop. Another example is the secretion of oxytocin which provides a pathway for the uterus to contract, leading to child birth.

Harmful Positive Feedback

Although Positive Feedback is needed within Homeostasis it also can be harmful at times. When you have a high fever it causes a metabolic change that can push the fever higher and higher. In rare occurrences the body temperature reaches 113 degrees Fahrenheit / 45 degrees Celsius and the cellular proteins stop working and the metabolism stops, resulting in death.

Bibliography

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