Acclimation for environment

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Introduction

The living body is surrounded by various changes in the environment. To maintain stability in physiological functions; is called *homeostasis.* The environment has been changing in long terms. The living body adaptability to various environments can form its own individuality. Therefore, adaptation is homeostasis that has been changed by environments. To live with health conditions, the living body is important to sympathize with the environmental changes. This is biological rhythms. There are many factors that affect the biological rhythms, e.g. light and temperature.

Homeostatic control of body temperature

A relatively constant body temperature is needed to standardise and co-ordinate the enzyme controlled reactions of metabolising cells. This allows us to continue to operate at the same basic rate, whatever the environmental temperature depends on a balance between heat production and heat loss. Variation in heat production are caused by:

1. metabolic rate due to physiological activity of tissues and organs.
2. muscle activity.
3. levels of hormones affecting metabolic rate, such as thyroxine and adrenaline.
4. the quantity of brown fat.

On the other hand, variations in heat loss are caused by:

1. the temperature gradient between the skin and the environment.
2. the nature of the environment such as air or water.
3. the surface area to volume ratio.
4. the humidity of the environment.
5. the insulating effect of the subcutaneous fat.

Most of the heat is generated in the core of the body; is circulated in the blood vascular system; and is lost through the surface of the skin. Most heat will be lost in areas where the surface area to volume ratio is high, as in the limbs. Thus the regulation of the body temperature is via the blood supply to the skin. More blood to the skin produces more heat loss,, less blood to the skin means less heat loss.

The role of the hypothalamus.

The response of the blood vessels is not to how hot or cold we feel through the exteroceptors of the skin. The core temperature is detected by interoceptors, through to be located in the hypothalamus, a region of the brain located below the cerebral hemispheres. When the temperature of the blood in the hypothalamus rises above 37^{O}C action potentials are initiated in the motor neurones of the autonomic nervous system. This causes the smooth muscle of the skin arterioles to relax and dilate the vessels. This stimulates the production of sweat, and causes the skin to look flushed.

When the temperature of the blood in the hypothalamus falls below 37^{O}C action potentials are initiated in motor neurones supplying the skeltal muscles, causing shivering, and in motor neurones of the autonomic system supplying the skin, causing the smooth muscle of the arterioles to contract the vessels. This causes the skin to look pale. With delusions of grandeur, the erector muscles of the hairs also contract. This causes goose pimples, but does no good at all. In furry mammals it increases the thickness of the insulating layer of air trapped in the hair. The net result is that there ia a very efficient mechanism in sweating to keep the body cool, but a less efficient system for keeping the body warm. We compensate for this by voluntary muscular activity, and by wearing clothes.

Fevers that accompany certain diseases occur when the thermostat of the temperature receptors of the hypothalamus are reset at a higher temperature. This may be advantageous in increasing the metabolic rate for an immunological response, or it may be effective in denaturing the pfoteins of pathogens.

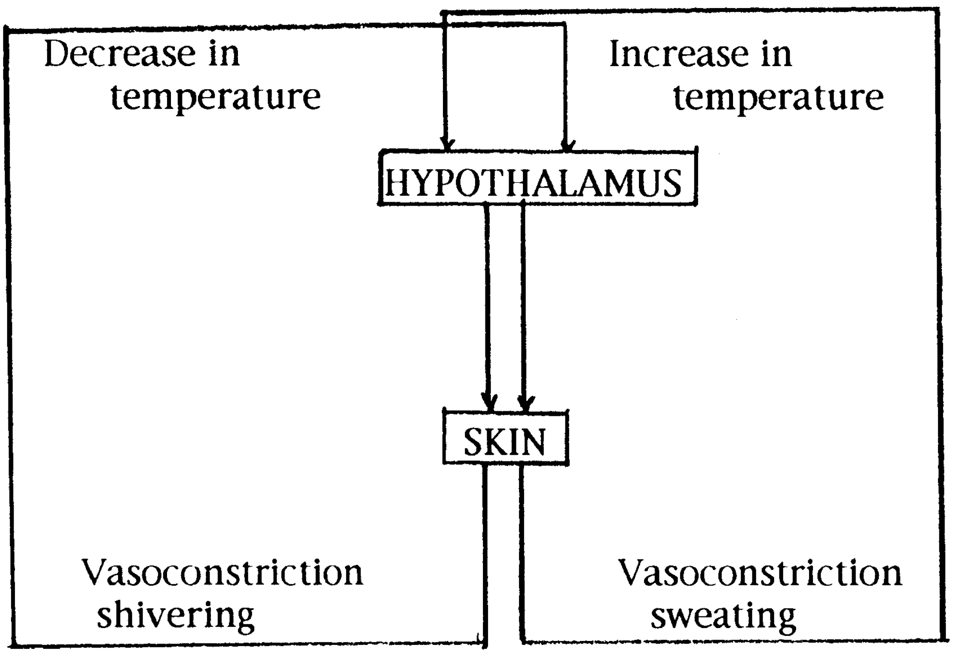

Figure1. Diagram to show the Homeostatic Control of Body Temperature

Adaptation for heat temperature

Automatic control of body temperature in the heat environment are as follows;

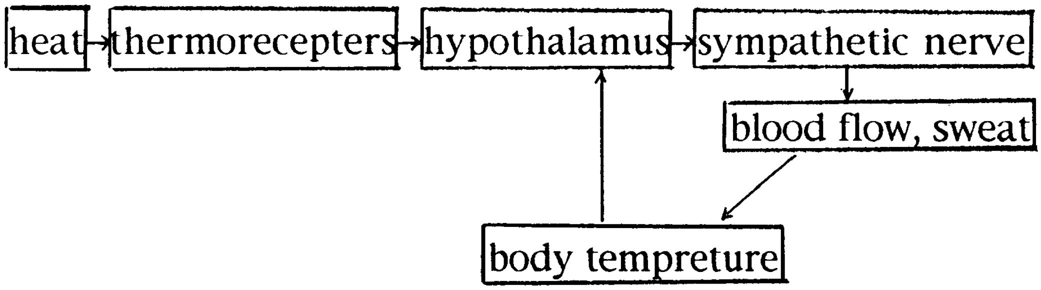

Figure2. Feed back control of body temperature

When it is exposed by high temperature, we have adaptation for this (above). Mainly mechanisms of control for heat are caused by increase of heart rate and then blood flow. That reason is to release heat from the body. Accordingly, it becomes to functional overwork for heart in the elderly people. It could be heart failiar. During running under the heat tempreture, it could be continued exercise by brain cooling. However, after running goal, it has increase of risk factor that cause to collapse by less of forced convection to the selective brain cooling (forced convection). For the acute adaptation to heat environment, increase of plasma noradrenaline is needed during running exercise (Figure 3).

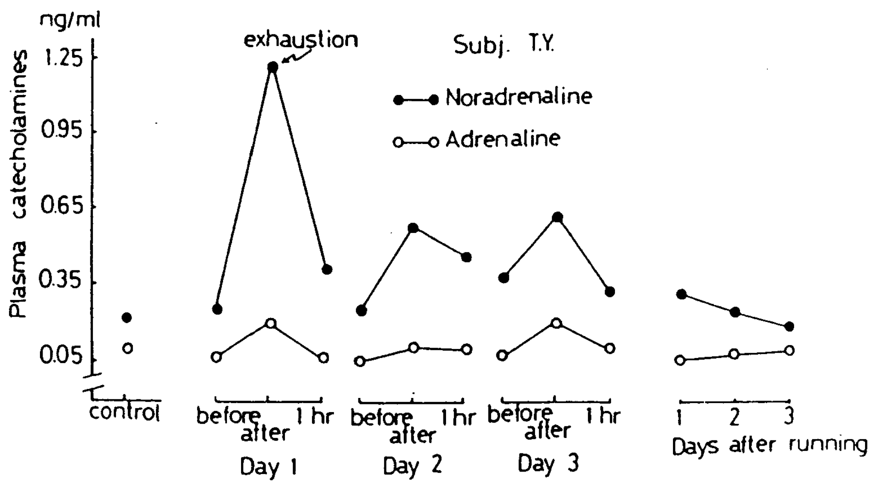

Figure3. Running under heat environment. (Yamamoto, 1978). The running was carried out under 35°C-37°C (August, 1978, in Tokyo) for three days. Day 1 showed exhaustion for 2.3Km running, but not for day2 and day3 (5Km running) after completion of heat adaptation.

For the adaptation to heat envirnment for a long term, dynamic hormone response are important; increased secretion of aldsterone (Ald) and ADH (antiduaritic hormone), and also decreased secretion of noradrenaline, thyroxine and glucagon. Furthermore, it shows enhanced heat volume and stroke volume with decreased heart rate.

Adaptaion for cold temperature

For the cold environment, there are two important mechanisms; enhancement of peripheral nervous system and lipid metabolism. In the first stage, it is important to enhance motor neuron that causes shivering. This mechanism produce body heat by skeltal muscle contraction. The contraction of blood vessels, caused by sympathetic nerves, inhibit heat and release body tempreture. The long term adaptation to cold environment, is observed high maintenance of noradrenaline concentration (Figure 4). This mechanism cause increase in FFA by lipolisis, and then produces the heat that is processed from non-shivering.

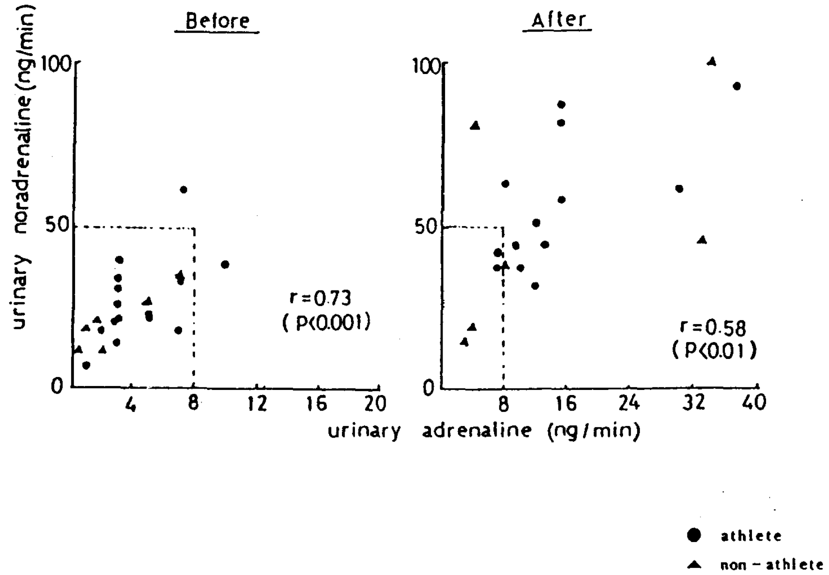

Figure 4. Urinary catecholamines excrete under cold stress. (Yamamoto, 1978). Normal subjects were exposed the body (except for head and face) into the cold water (20°C) for 15 min.

Circadian Rhythmicity

In recent studies, origin of the biological rhythms has been identified. That is in suprachiasmatic nucleus (SCN). SCN govern from ascending reticular activating system to peripheral nerve (as shown NA; Noradrenaline and A; Adrenaline in Figure 5) and hormonal systems, and this produce biological rhythms (Figure 5). They are expressed and reflected as a behavior. If we change life style such as daytime-sleeping and night-time-working, it need 21 days to complete the body temperature rhythms to get used to this life style. In contrast, if it switch from normal life style, it is very easy to recover from biological rhythms (only 2 days). On the other hand, if it take night time -working and day time-sleeping for only one day, its body tempreture pattern will still be normal, and not changed.

It has been known that there are many seasonal associated disease (SAD) in the northern areas in the world (e.g. Norway) where it is lack of sunshine in the winter season. This disease cause depression in the winter and is associated with abnormal secretion rhythms of melatonin. Also, Figure 5, the data shows that autonomic nervous system has circadian rhythmicity which are noradrenaline and adrenaline activities.

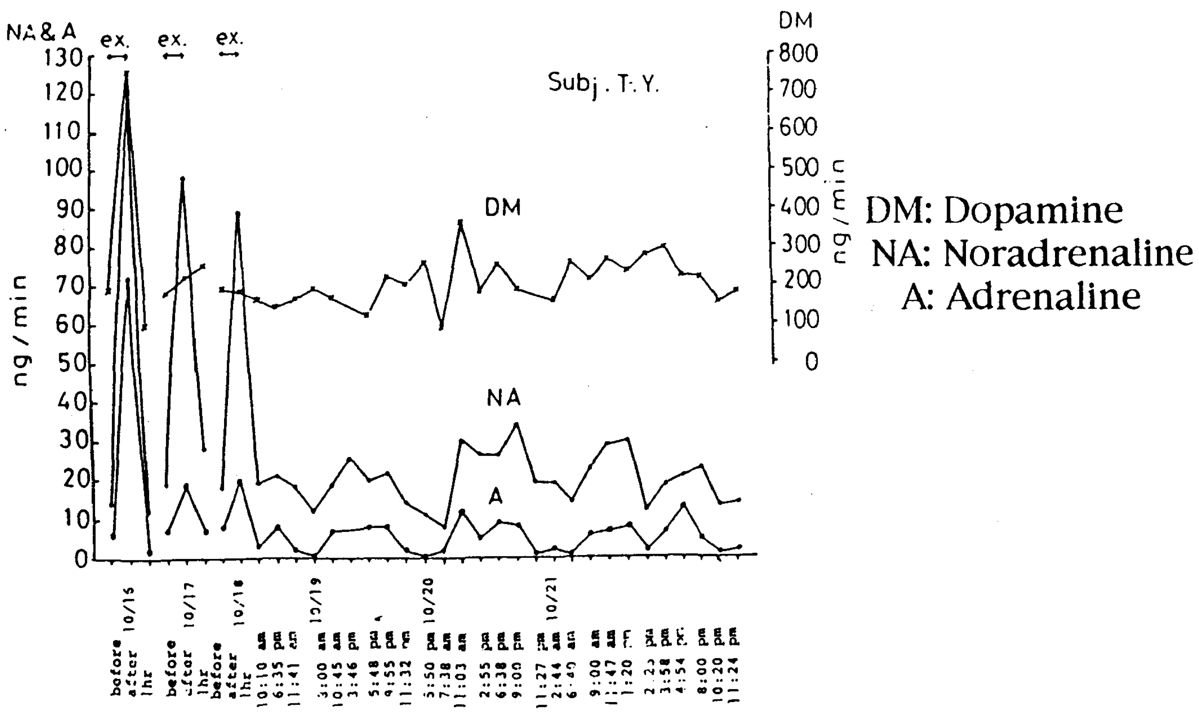

Figure 5. Circadian rhythms; Catecholamines excretion and life activity. (Yamamoto, 1978)

Summary

In heat environments, when adaptation to "heat-stress" is not yet formed, it leads to an increase in ratio of death owing to heart failier (50% rising for average). The body adapts to heat stress by heart beating. An information of "heat-stress" is recieved by antero-hypothalamus (warmth neuron) via changes of brain blood flow and/or sense nerve from peripheral thermoreceptors. Then, vasodialation, enhanced heart rate and sweat secretion are caused by negative feedback regulation via autonomic nerve system. Continuously, check and integration of temperature through the hypothalamus are conducted by information from cutaneous, deep and visceral sensation.

The exercise under the heat environment causes increase in heart-stroke, by rising muscle and brain temperature. After heat adaptation, Ald, ADH, plasma volume, stroke volume, venous return and sweat secretion increase. On the other hand, heart-rate and core temperature decrease.

Cold stimulation, expresses shivering, pilomotor response and vasoconstraction at the first stage. After adapting cold environment, there is a chronical increase level of noradrenaline: regulatory nonshivering thermogenesis.

Biological clock exists in the SCN which depend on light stimulation. SCN function play an important role for the control of functional biological rhythms.

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