Investigation

1 Homeostasis

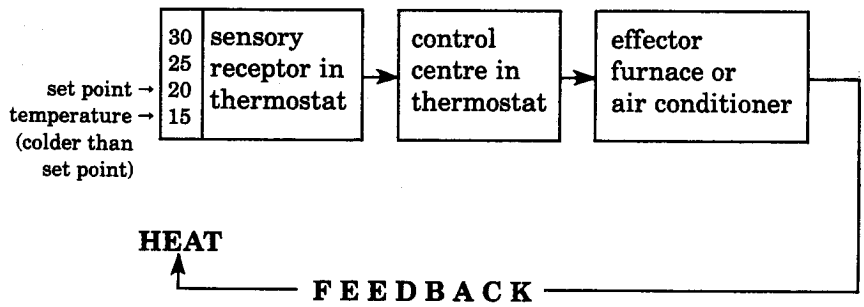
Introduction

The term *homeostasis* means literally "staying the same". More specifically, homeostasis is the process by which an organism maintains a constant internal environment in spite of changes occurring in the external environment.

The cellular fluid that is found in an organism is very important in this process. For example, the human body contains water in which gases, mineral ions, foods, vitamins, hormones and wastes are dissolved. In order to remain healthy, the amount of water, the concentrations of these dissolved substances, the pH and the temperature of the cellular fluid must remain relatively constant. Maintaining a constant internal environment requires the work of nearly every organ-system within the body. Thus, homeostasis is a concept that links virtually all the organ-systems.

All homeostatic mechanisms have three parts: a *sensory receptor*, a *control centre* and an *effector*. The sensory receptor detects a particular stimulus from the internal or external environment and relays this information to the control centre. The control centre (usually the brain) interprets the information and directs certain *effectors* (usually muscles or glands) to respond. The response by the effectors is detected by sensory receptors and "checked" by the control centre to determine if the response was appropriate. This process of checking the response is called *feedback*.

These components of homeostatic mechanisms can be diagrammed. We will use the regulation of air temperature in a home as an example.



In this example the temperature of 15°C is below the set point temperature of 20°C. As a result, the thermostat would detect the difference and, via its control centre, turn the furnace on to supply heat. The rising temperature is called *negative feedback* because the heat provided by the furnace reverses or negates the colder temperature.

Most homeostatic mechanisms involve negative feedback. For example, when you are tired, you sleep; when thirsty, you drink; when hungry, you eat. In each case the effect reverses or negates the initial condition.

Positive feedback increases or "adds to" the initial condition. In most cases positive feedback would not be a useful homeostatic mechanism, since it would worsen an already unsatisfactory condition. Nevertheless, there are a few instances in which positive feedback is desirable. One example is childbirth in which the muscle contractions of the uterus push the baby's head towards the cervix (opening of the uterus). The stretching of the walls at this lower end of the uterus increases the intensity of the uterine contractions which further stretches the cervix, which increases the contractions . . . and so on. Fortunately, this "vicious cycle" of events does not continue for ever. Normally this positive feedback process ends happily with the birth of the child. Since positive feedback does not lead to the maintenance of constant and stable conditions it is not considered a homeostatic mechanism.

Purpose

To investigate how the homeostatic mechanism of body temperature regulation functions.

Equipment

oral thermometer
watch

Procedure

Take your body (oral) temperature by placing the thermometer under your tongue for 3 minutes. It may be necessary to give the thermometer two or three vigorous shakes to ensure the fluid is below 35°C. Record your temperature to the nearest 0.1°C. Record your breathing rate and heart rate for one minute at rest. Have your partner count the number of breaths (inhalation and exhalation) you take during one minute. You will obtain a more accurate breathing rate if you have someone else count your breaths. Meanwhile, you can be taking your pulse at the carotid artery on the side of your neck just beneath your jaw, or radial artery at your wrist on the thumb side. Reverse these roles to determine your partner's breathing and heart rates.

Do 15 to 20 minutes of moderate to vigorous exercise such as running, jazzercise, squash, racketball, or basketball. Regardless of the type of exercise you select, two things to keep in mind are: the exercise should be what you are accustomed to, and it should be aerobic. Aerobic exercises require you to work hard, use plenty of oxygen and thereby stimulate heart and lung activity.

Arrange to finish your exercise with your partner so that you can immediately take and record your breathing rate, heart rate and oral temperature. Observe and record the appearance of your face, neck and shoulders. Continue to take and record your oral temperature at 5-minute intervals for 20 minutes or until it reaches your resting temperature.

Calculate the difference between your breathing rate, heart rate and oral temperature at rest and immediately after exercising. Record these differences with your other observations in a chart similar to the one shown on the next page.

Observations

Type of exercise _____

Location _____

Surrounding temperature _____

	Breathing rate (/min)	Heart rate (/min)	Oral Temp. (°C)	Appearance of face, neck shoulders
Resting				
Immediately after exercise				

Oral temperature:

Resting	
After exercise:	5 min after
	10 min after
	15 min after
	20 min after

Questions

1. a) Explain the difference in oral temperature at rest and immediately after exercise.
   b) List three external factors that may result in a greater or smaller difference in oral temperature. Explain how these factors influence the difference.
2. a) Describe three homeostatic mechanisms that are used to control your body temperature.
   b) Describe the mechanisms involved in regulating your body temperature in this investigation. Refer to the specific observations that you made.
   c) Prepare a flow chart of these mechanisms that indicates feedback.
3. Define homeostasis.
4. Describe the three components of a homeostatic mechanism and name the specific components involved in the regulation of body temperature.
5. a) Explain why negative and not positive feedback is more common.
   b) Explain how the following examples illustrate positive feedback: blood clot formation, courtship and mating, and the depolarization of an axon resulting in an action potential.
6. Describe the following conditions with respect to their cause, symptoms and cure or control: fever, heat stroke, heat exhaustion, hypothermia, and frostbite.
7. Describe how a countercurrent heat exchanger functions in maintaining body temperature.