1. Explain how the integumentary system and the circulatory system work together to maintain homeostasis while you are playing outside.

The integumentary system produces sweat, which cools the body as it evaporates. Blood vessels in this system may dilate to release excess heat to the environment.

2. Explain how the respiratory, circulatory, and nervous systems maintain homeostasis while you are playing outside on a sunny day.

The respiratory system allows for gas exchange and helps to ensure the blood is oxygenated and carbon dioxide is removed. The circulatory system transports oxygen to the tissues of the body and picks up carbon dioxide and other wastes. Blood vessels become dilated to allow greater release of heat if the body becomes hot. The nervous system instructs blood vessels to contract or dilate, as needed, and diverts blood flow to where it is required.

3. Describe the interactions that occur between the circulatory system and the muscular system during exercise.

As you exercise, the muscular system produces more carbon dioxide, which needs to be removed, and requires more nutrients and oxygen. The circulatory system brings these nutrients to the muscle tissues and takes away the carbon dioxide.

Principles of Homeostasis

1. **Receptors (detect stimuli), control and coordination center (integration of signals and coordination of response), effectors (implement an appropriate response).**

2. **Negative feedback mechanisms enable! maintenance of a steady state internal environment despite fluctuations in the external environment (e.g. rising air temperature). Negative, feedback mechanisms are self-correcting so that physiological systems are! stabilized against excessive change.**

Maintaining Homeostasis

1. Two mechanisms operating to restore homeostasis after infection ((a) and (b) any two of):

- **Immune system response with the production of antibodies against the antigens of the pathogen (humoral response).**

- **Immune system response with the production of T cells which recognize the antigens of the pathogen and destroy them 'directly (cell-mediated response),**
- **Local inflammatory response (redness, pain, swelling, heat) at the site of infection,**
- **Fever (widespread increase in body temperature).**
- **The production of antimicrobial substances like interferon and interieukin-1.**
- **Phagocytosis of pathogen by white blood Cells. All the above aim to destroy the pathogen and/or its toxins and assist a return to homeostasis,**

2. Mechanisms by which responses to stimuli are brought about and coordinated:

Hormonal response to stimuli: Endocrine glands respond to a stimulus (e,g. a nerve impulse or another hormone or metabolite) by producing hormones which bring about an appropriate physiological response. For example, nervous stimulation of the adrenal glands when the body receives a stressful stimulus causes the release of epinephrine. This hormone causes mobilization of glucose in muscle and liver cells, increases heart rate and directs blood away from nonessential organs. These responses help the body react to the stress situation,

Nervous response to stimuli: Direct stimulation of nerves from a sensory receptor causes a reaction to the stimulus. This may be a response requiring interpretation of the message by the brain or It may be a reflex (an automatic response to a stimulus involving only 2 or 3 neurons), e.g. pain withdrawal.

3 Maintaining water and ion balance by:

Water and ions are taken in with food and drink,, helping to replace that lost through urine, faeces and sweat. The digestive organs and all of the digestive hormones (e.g. amylase in the mouth pepsin in the stomach trypsin in the small intestine) are all involved in breaking down food and facilitating absorption into the bloodstream.

The kidney is the primary regulator of fluid and ions. When large quantities of fluid must be excreted, the kidney produces large amounts of dilute urine. When water must be conserved, small amounts of concentrated urine are produced, ADH (antidiuretic hormone) causes more water to be reabsorbed from the kidney (causing more concentrated urine). ADH Increases when blood water levels are low. Essential ions (and glucose) are retained by active reabsorption from the kidney tubules. Another hormone aldosterone from the adrenal glands increases the absorption of sodium ions. Note: Water and ions are lost via sweat and water

is lost in breathing.. These losses are compensated for by the homeostatic role of the kidney. Note that sweating is a mechanism. For thermoregulation, it is not usually an important way to rid the body of excessive water and salts.

4. Regulating respiratory gases during exercise by:

(a) Increasing breathing rate. This increases both the rate of oxygen entering the lungs and the rate at which carbon dioxide leaves. It also increases the rate of loading and unloading of oxygen and carbon dioxide Into and out of the bloodstream..

(b) Increasing the heart rate.. This increases blood flow which facilitates the loading and unloading of oxygen and carbon dioxide Into and out of the bloodstream. It also Increases the speed of delivery of oxygen to working tissues (e.g. muscles) and speeds up the removal of carbon dioxide and other waste products of metabolism.

Homeostasis During Exercise (page 226)

1. (a) The output of the heart increases more than five times.
   (b) This increase is necessary because the heart must pump more blood in order to supply more oxygen to working muscles. In addition, an increased rate of blood flow ensures that metabolic waste products, which are produced at a higher rate during exercise, are removed as quickly as they are produced.
   (c) Heart and blood vessels (circulatory system).

2. (a) Oxygen consumption increases twenty times or more. Most of this increase occurs in the muscle.
   (b) An increase in metabolic activity associated with muscles working harder increases the requirements for oxygen (to supply the aerobic respiration of the muscle cells).
   (c) Resting muscles use about the same amount of oxygen as other tissues. During exercise, the muscles account for most of the total increase in oxygen consumption, i.e. the metabolic activity of the muscles increases greatly when they are working (contracting).

3. A trained athlete has a greater cardiac output (total blood flow) and a greater total oxygen consumption during exercise than an average man. The athlete's muscles adjust during training to working at a higher rate and during heavy exercise they demand more oxygen (and a higher blood flow) than the muscles of the average man. Note also that a trained athlete diverts slightly more blood (and oxygen) to the muscles at the expense of other tissues during exercise. This is a physiological adjustment made as a result of training to increase the working capacity of the muscles.