Actions of thyroid hormone

1. **Functions of Thyroid Hormones in the Tissues**

Thyroid Hormones and Transcription of Many Genes After thyroid hormones enter the cell and bind to nuclear receptors in the DNA. This interaction either stimulates or inhibits transcription of a large number of genes. This leads to alterations in numerous enzymes that alter cell function. The actions of T3 occur more rapidly and are more potent than are those of T4 because T3 is bound less tightly to plasma proteins and has a greater affinity for nuclear receptors. Because thyroid hormones act in large part through influencing transcription, a delay of several hours occurs before most hormonal effects are evident; these effects may last several days.

2. **Physiological Effect of Thyroid Hormones—Cellular Metabolic Rate**

In most tissues of the body, thyroid hormones increase oxygen consumption and heat production. Mitochondria increase in size and number, the membrane surface areas of the mitochondria increase, and the activities of key respiratory enzymes increase. A complete accounting of the cellular mechanisms responsible for the higher oxygen consumption is not possible at present. Because thyroid hormones increase the activity of membrane-bound Na, K-ATPase,the greater ATP consumption associated with the greater sodium transport is believed to contribute to the greater metabolic rate induced by thyroid hormone.

3. **Specific Physiological Effects of Thyroid Hormones Many of the Effects of Thyroid Hormones are Secondary to Increased Metabolic Rate**.

Thyroid hormones are responsible for the following functions:

• Increased thermogenesis and sweating. Skin blood flow increases because of the need for heat elimination.

• Increased rate and depth of respiration resulting from the need for oxygen.

• Increased cardiac output because increased metabolism and utilization of oxygen in tissues cause local vasodilatation. Increased cardiac output is associated with elevations in both stroke volume and heart rate, in part because thyroid hormones have direct and indirect effects on the heart to increase the heart rate and force of contraction.

• Increased pulse pressure but not mean arterial pressure. Because of the increased cardiac output (stroke volume) and reduced peripheral vascular resistance, systolic

arterial pressure is elevated and diastolic arterial pressure is reduced. This results in an increase in pulse pressure but usually no change in mean arterial pressure.

• Increased utilization of substrates for energy. An increased metabolic rate is dependent on oxidation of metabolic substrates. Thyroid hormones increase the utilization of carbohydrates, fats, and proteins for energy. If food intake is not increased sufficiently, there is depletion of body fats and proteins and weight loss. Although thyroid hormones promote lipolysis of triglycerides and increments in plasma levels of free fatty acids, they also decrease the circulating levels of cholesterol; this action is due to increased formation of low density lipoprotein receptors in the liver, resulting in increased removal of cholesterol from the circulation. Because thyroid hormones increase the rate of metabolic reactions, the need for vitamins is greater, and excess thyroid hormone can lead to vitamin deficiency.

4. **Thyroid Hormones Are Essential for Normal Growth and Development**. Thyroid hormones are essential for many aspects of growth and development; they play an important role in the development of the skeletal system, teeth, epidermis, and central nervous system. In hypothyroid children, the rate of growth is greatly reduced. An important effect of thyroid hormone is to promote growth and development of the central nervous system in utero and for the first few years of postnatal life. If thyroid hormone is deficient at this time, irreversible brain damage occurs.

5. **Thyroid Hormones Have Excitatory Effects on the Nervous System.** Thyroid hormones enhance wakefulness, alertness, and responsiveness to various stimuli; they also increase the speed and amplitude of peripheral nerve reflexes and improve memory and learning capacity.