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T3: Master Regulator of Health and Disease

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Introduction

This review illuminates the critical function of thyroid hormones, particularly T3, in regulating the cardiovascular system. It explains how T3 impacts heart rate, contractility, and systemic vascular resistance, detailing both normal physiological roles and the consequences of thyroid dysfunction, like cardiac manifestations[1].

This article highlights T3's multifaceted role and its receptors in liver metabolism. It delves into how T3 influences glucose, lipid, and cholesterol homeostasis, discussing its impact on conditions such as hepatic steatosis and insulin resistance. The insights here position T3 as a promising target for liver disease therapies[2].

This review clarifies T3's pivotal role in brain development, affecting neuronal differentiation, myelination, and synaptic plasticity. It also explores how disruptions in T3 signaling can lead to various neuropsychiatric conditions, ranging from early developmental disorders to mood disorders in adulthood[3].

This paper highlights the crucial role of T3 in activating and regulating brown adipose tissue (BAT) thermogenesis. It explains the molecular mechanisms through which T3 boosts BAT activity, leading to increased energy expenditure and heat production, and suggests its relevance for treating obesity and metabolic issues[4].

This review dissects the intricate connection between thyroid hormones, specifically T3, and various aspects of cancer growth. It outlines how T3 influences cell proliferation, differentiation, programmed cell death, blood vessel formation, and spread in different cancer types, pointing to its potential as a prognostic tool or therapeutic target[5].

This review elaborates on T3's vital involvement in skeletal muscle development, maintenance, and repair. It details how T3 impacts muscle fiber types, mitochondrial function, and protein synthesis. The insights here suggest T3's therapeutic relevance in conditions like sarcopenia, where muscle wasting is a concern[6].

This review explores T3's profound effect on systemic glucose and lipid balance. It explains how T3 directly and indirectly modulates insulin sensitivity, glucose uptake, gluconeogenesis, and lipid synthesis/breakdown across various tissues, underscoring its pivotal role in metabolic control and its implications for managing diabetes and dyslipidemia[7].

This review highlights T3's essential role in regulating mitochondrial biogenesis and function in different tissues. It describes how T3 impacts mitochondrial DNA replication, protein synthesis, and the electron transport chain, thereby influencing cellular energy production, thermogenesis, and overall metabolic health, with implications for metabolic disorders[8].

This article discusses T3's considerable influence on bone metabolism, covering both bone formation and breakdown. It outlines how T3 directly affects bone-forming and bone-resorbing cells, which helps maintain bone mineral density. The piece also examines how imbalanced T3 levels, as seen in thyroid issues, can contribute to conditions like osteoporosis or hindered bone growth[9].

This review stresses T3's crucial involvement in regulating growth and development, particularly during the prenatal and postnatal periods. It details how T3 influences skeletal maturation, linear growth, and the development of various organ systems, including the brain. The article highlights the severe consequences of T3 deficiency, such as growth retardation and developmental abnormalities[10].

Description

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This article highlights T3's multifaceted role and its receptors in liver metabolism. It delves into how T3 influences glucose, lipid, and cholesterol homeostasis, discussing its impact on conditions such as hepatic steatosis and insulin resistance. The insights here position T3 as a promising target for liver disease therapies[2]. This review explores T3's profound effect on systemic glucose and lipid balance. It explains how T3 directly and indirectly modulates insulin sensitivity, glucose uptake, gluconeogenesis, and lipid synthesis/breakdown across various tissues, underscoring its pivotal role in metabolic control and its implications for managing diabetes and dyslipidemia[7].

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Conclusion

Thyroid hormone T3 is a central regulator across numerous physiological systems, influencing a wide array of biological processes essential for health. In the cardiovascular system, T3 critically regulates heart rate, contractility, and systemic vascular resistance. Its metabolic impact is profound, extending to liver metabolism, where it manages glucose, lipid, and cholesterol homeostasis, and systemically, by modulating insulin sensitivity and lipid synthesis. T3 is also key in activating brown adipose tissue thermogenesis and regulating mitochondrial biogenesis, which are crucial for energy expenditure and metabolic health. Beyond metabolism, T3 plays a pivotal role in brain development, affecting neuronal differentiation and synaptic plasticity, with its disruption linked to neuropsychiatric conditions. It is fundamental for overall growth and development, influencing skeletal maturation and organ system development, where deficiency leads to severe abnormalities. T3 also contributes significantly to skeletal muscle development, maintenance, and repair, and influences bone metabolism by affecting both formation and breakdown. Lastly, T3's involvement in cancer growth, including cell proliferation, differentiation, and metastasis, points to its potential as a prognostic and therapeutic factor. These diverse roles underscore T3's significance in both normal physiological function and disease pathology.

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Conflict of Interest

None.

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