Handbook of Experimental Pharmacology

Volume 251

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Brown Adipose Tissue

Springer

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ISSN 0171-2004 ISSN 1865-0325 (electronic)
Handbook of Experimental Pharmacology
ISBN 978-3-030-10512-9 ISBN 978-3-030-10513-6 (eBook)
https://doi.org/10.1007/978-3-030-10513-6

Library of Congress Control Number: 2019933559

This Springer imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Spotlight on Brown Adipose Tissue: Four Short Questions

What Is Brown Adipose Tissue?

This simple question is not so easy to answer, because brown fat is a special type of fat that has not much in common with the adipose tissue that we usually associate with "fat," i.e., the white adipose tissue. White fat is our largest store of energy, whereas brown fat generates heat – this process is also called non-shivering thermogenesis, because it does not rely on muscle contraction and shivering. Energy expenditure by brown fat is physiologically induced by cold stress but can also be induced pharmacologically by the stress hormone norepinephrine. Brown adipose tissue is special because it expresses the unique uncoupling protein 1 (UCP1) that uncouples mitochondrial respiration from ATP production, thus generating heat. The location and quantity of brown fat vary with age and sex; it can be found mainly between the shoulder blades, in the neck, deep within the chest around the great vessels, and around the kidney.

What Is Beige Fat?

Adipose tissue exhibits a substantial degree of plasticity and depots can change their phenotype/color. White fat – especially the subcutaneous depot – can take on the appearance of brown fat. This process can be observed after cold exposure and is also known as "browning." These cells share many characteristics with brown adipocytes and are therefore called brown-in-white (thus the abbreviation brite) or beige cells. Importantly, beige fat can contribute to whole body energy expenditure, albeit to a lesser extent than brown fat.

Why Is BAT so Interesting at Present or Why Do We Need a Compendium of Reviews on BAT Now?

Obesity has reached pandemic dimensions, and there is a lack of specific and efficient pharmacological treatment of overweight and obesity. Thus, there is high medical need for novel treatment strategies, and increasing energy expenditure has been suggested to be a potential strategy to fight obesity. But how can energy expenditure be achieved? Telling obese people to exercise is obviously not enough. The publications in 2007 and 2009 showing that adult humans possess metabolically active brown fat and that its activity correlates with leanness sparked off new interest in this special type of fat. Many labs shifted their attention to brown and beige fat, and since the last decade a wealth of new studies have been published on this topic.

This review is especially dedicated to those scientists newly intrigued by the metabolic power of brown adipose tissue.

How Is This Handbook Structured?

The 21 articles of the handbook are arranged into four parts:

- Part I focuses on the differences in the development of brown versus beige adipocytes and how brown adipocytes can be cultured in vitro. The focus of the articles on adipocyte models lies on human brown adipocytes. In addition to technical aspects of lineage tracing in vivo, aspects of brown adipocyte aging are covered in this chapter.
- Part II centers on molecular mechanisms of BAT function, especially on UCP1, and signaling mechanisms. The latter encompass papers on novel lipid signals that control BAT and the second messengers cAMP that plays a major role in BAT activation and its "smaller sister/brother" cGMP, which is getting more attention as an important enhancer of brown adipocyte differentiation. This chapter also deals with the expanding field of noncoding RNAs (microRNAs and long-noncoding RNAs) of BAT and beige fat. It is well established that white fat secretes a broad spectrum of hormones and endocrine factors (e.g., leptin and adiponectin), and recent studies suggest that BAT also has endocrine functions.
- The function of BAT in human adults is still not completely understood. A major hurdle is the lack of efficient and cheap diagnostic markers that do not expose subjects to radiation (X-ray and radioactive tracer). This is the topic of Part III.
- Finally, Part IV deals with BAT activation in humans by foods and drugs. The handbook closes with a detailed review of the potential of BAT as a pharmacological target.

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