9 Energy expenditure II – heat production

In principal, heat is generated as a by-product of the energy produced to maintain the body's basal and active metabolic rates (▶ Chapter 8 and ▶ Chapter 10). By steering metabolism, the iodine-containing thyroid hormones work as the main regulators of heat production. This process mainly takes place in the muscles, although heat generation is also possible in the fatty tissue. Here, we must differentiate between white tissue and brown tissue: Thermogenesis primarily takes place in brown adipose tissue (BAT). To date, this has only been unequivocally detectable at higher concentrations in neonates in their first days of life. The additional heat produced by this fat protects babies against cold. However, because this BAT rapidly undergoes involution with increasing age, it stops playing any major functional role for a long time. BAT is endowed with a rich blood and nerve supply, while refined techniques have meanwhile been developed that can detect minor – sometimes even larger – amounts of this tissue along the great arteries in adults (Lee et al. 2013).

In the mitochondria of this specialized tissue is where uncoupling protein-1 (UCP1, **thermogenin**) resides. Other uncoupling proteins (UCPs) can be found in skeletal muscle and white adipose tissue. Thermogenin especially, but also the other UCPs, cut off the flow of hydrogen ions at the inner mitochondrial membrane. This process is initiated by noradrenaline. Here, it reacts with a β-receptor coupled to a G protein and results in defective adenosine triphosphate (ATP) synthesis (▶ Chapter 6).

Nevertheless, ATP is the actual driver of energy metabolism in the body. To a certain degree, it is the "electric current" essentially enabling all vital processes in cells to run at all. Therefore, ATP must always be rapidly produced in adequate amounts from carbohydrates and fats. However, if ATP synthesis is inhibited, more of the consumed dietary energy is directed to this important process, with the result that heat release increases and a possible energy surplus is less likely to be stored in the form of fat. Some individuals benefit from the energy-consuming properties of UCPs to a greater extent because they produce more of such proteins. The disturbance of biological processes caused thereby allows those affected to apparently eat as much as they want and still remain slim. This unique characteristic of a metabolism that constantly overproduces heat is also referred to as **"non-exercise activity thermogenesis"**.

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