# BEIGE ADIPOCYTE

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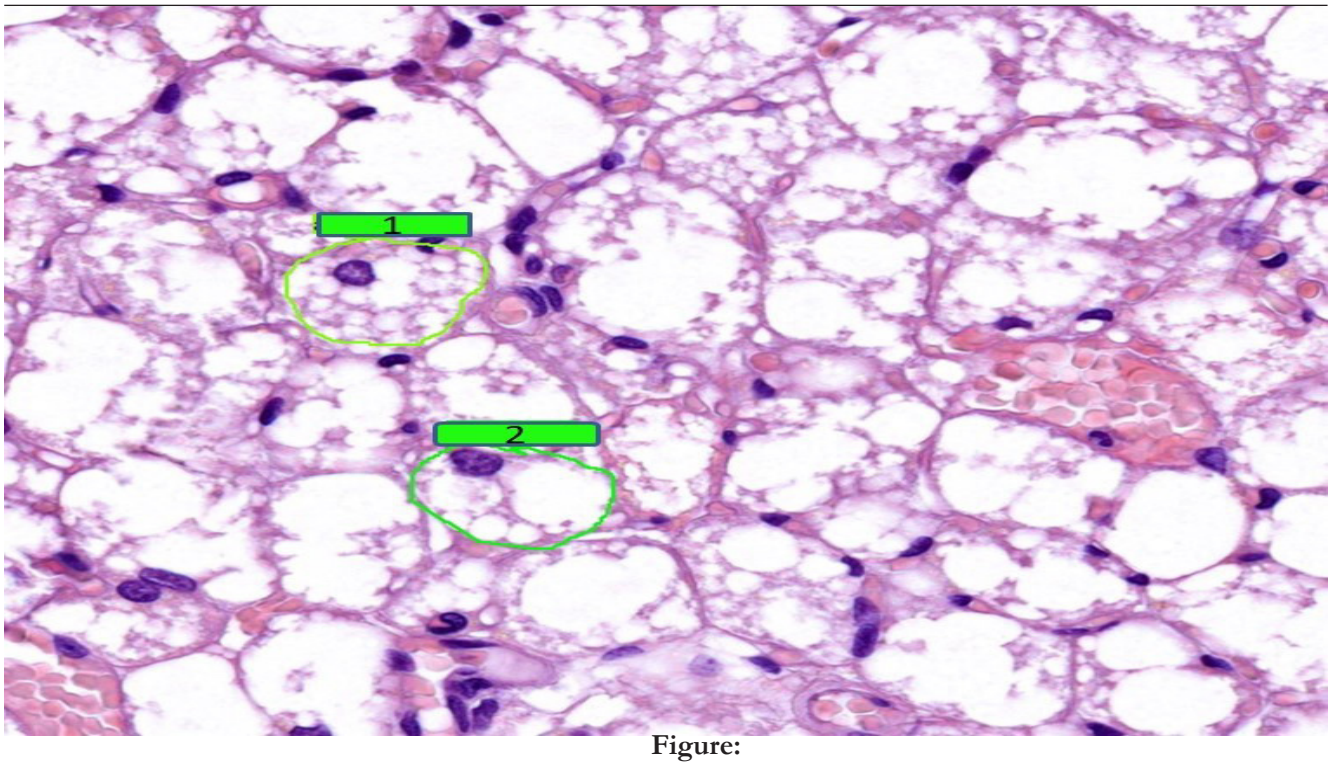


**Figure:**
(1) most probably a brown multilocular adipocyte; (2) most probably a beige paucilocular adipocyte. Note the presence of one large lipid droplet, and some independent smaller ones. HE, X 40

Classically, in the human body there were recognized two types of adipose cells-tissues: white adipose tissue (WAT), and brown adipose tissue (BAT), the later one being restricted to the fetus and children in the first year of life. The two types of adipose tissue have opposite functions: while WAT stores energy, BAT consumes it for adaptative thermogenesis. For this purpose, brown adipocytes have a unique mitochondrial protein called uncoupling protein 1 (UCP1). The beige adipocyte, also known as the brown-like adipocyte, brite (brown in white), or paucilocular adipocyte, was initially identified as the adult's inactive brown adipocyte. With the introduction of computer tomography with positron emission (glucose marked with radioactive fluorine), it was observed that in laterocervical and supraclavicular areas there was an intense glucose –uptake. Studies carried out subsequently on mice and human biopsies demonstrated the presence, in those areas, of both active brown adipocytes, and of another cell type that had an intermediate morphology between white and brown adipocytes, and that expressed UCP1 as brown adipocytes do.

This cell type was called beige adipocyte.

**Location**. Under thermal comfort or in the absence of β adrenergic receptors stimulation, the beige adipocytes are located along with the brown adipocytes, in the laterocervical, supraclavicular, axillary, paravertebral and adrenal glands regions. After prolongued exposure to cold (temperatures below 5 ° C), beige adipocytes may appear in any subcutaneous and visceral WAT deposits (most frequently in inguinal region). The clusters of UCP1+ beige adipocytes are mixed with not separated from white adipocytes.

**The origin** of beige adipocytes is incompletely elucidated, but they are known to have a different origin than brown adipocytes. Studies in mice have shown that most beige adipocytes appear through transdifferentiation of white adipocytes after prolonged cold exposure or β adrenergic receptor agonists stimulation. At the same time, it was demonstrated the differentiation of beige adipocytes from various perivascular precursors found in the white adipose tissue: adipogenic precursors, precursors of vascular smooth muscle cells, or even precursors of endothelial cells (after prolonged

exposure to extreme cold). Beige adipocytes do not proliferate. Under thermic comfort, these cells have both morphological and functional features similar to white adipocytes, from which they can`t be distingueshed. When stimulated again, they revert to UCP1 + beige adipocytes, a reconversion that occurs in parallel with the differentiation of new beige adipocytes from the perivascular precursor cells. In the differentiation of beige adipocytes, along with exposure to cold, stimulating roles have also some food compounds (resveratrol, capsaicin), physical effort (irisine), norepinephrine, natriuretic factors, etc.

The beige adipocyte`s morphology depends on its status. Under cold stimulation its morphology is similar to that of the brown adipocyte: it is a medium size cell, smaller than the white adipocyte, with an eccentric, pale nucleus, and an acidophilic cytoplasm with multiple mitochondria, and only few lipidic drops (paucilocular). Typically, there is one larger lipid droplet that is surrounded by multiple small ones (Figure below). In the absence of cold stress the beige adipocyte transdifferentiates into white adipocyte, taking its morphology: large, unilocular adipocytes, with flattened nucleus, and only few mitochondria.

In the **electronic microscopy**, the beige adipocyte`s lipid drops are surrounded each by membranes. The rather numerous mitochondria have an intermediate morphology: they are oval in shape-like in the white adipocyte, but with relatively numerous cristae - as in the brown adipocytes.

**Immunohistochemically**, the mitochondria in stimulated beige adipocyte show an intense positive reaction for UCP1.

**Functions**. Along with brown adipocyte, beige adipocyte is involved in adaptive thermogenesis, and in this context, it also intervenes in energy homeostasis. Even if it doesn`t consume as much energy as BAT in the thermogenetic process, it compensates by being largely spread in the body (wherever WAT is found). The combined action of the two types of UCP1+ adipocytes is capable of clearing 75% of the circulating glucose, and 50% of the circulating triglycerides in the thermogenic process. In this way, they are involved in improving the glycemic and lipidic profiles, and consequently in the prophylaxis of obesity and type 2 diabetes. So it is only natural to draw the conclusion that finding a way to promote beige adipose tissue formation or/and increasing its lipid expenditure, means finding a way to fight obesity and type 2 diabetes. Unfortunately obesity is associated with inflammation. The presence of M1-like macrophages that synthesize inflamatory cytokines reduces the number of beige adipocytes via two mechanisms: on one hand the differentiation of beige adipocytes is impaired, and on the other hand beige and brown adipocyte apoptosis is inhanced. Another factor that is unfavorable for the beige adipocyte development in obesity is the reduced number of sympathetic nerve endings per surface unit.

Even with all these obstacles, beige adipose cells remain a tempting target in the war against obesity and type 2 diabetes mellitus. There is still much to learn about these cells and their precursor`s biology, leaving a large field for future investigations.

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