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Some cattle breeds, including Hereford and Angus, have more BAT than Brahman cattle, which have calves struggling to survive in cold climates. *Photo by Paul Marchant.*

Brown fat ensures survival in calves

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Why do some calves survive the rigors of being born in cold, wet weather while others in the same situation die of hypothermia? Good mothers make a difference, but research shows that calves' survival depends on brown fat. Also called brown adipose tissue (BAT), its function is to generate body heat by non-shivering thermogenesis.

BAT is tucked between the shoulder blades and covers the heart, kidneys and major blood vessels. Stephen B. Smith, Ph.D., professor of animal science at Texas A&M University, says he considers this specialized fat to be an organ because it has a blood supply and a specific purpose. Vast amounts of mitochondria, the energy-producing structures in cells, give BAT a unique reddish-brown color.

"If calving occurs in winter or a cold spring, BAT generates heat by a process known as non-shivering thermogenesis, using fatty acids," Smith explains. "BAT provides additional protection for the internal organs. The function of BAT is to keep the newborn alive if it is born in a very cold environment."

This system warms the blood, which spreads heat throughout the body. Temperatures below 50ºF kickstart the heat-generating properties of BAT. BAT deposits decline within a month; the remnant changes into white adipose tissue (WAT) as large numbers of energy-producing mitochondria disappear.

"The fact that all adipose tissue starts prenatally as BAT rather than as WAT and that it's located around the internal organs indicates this is an important mechanism for survival," Smith reveals.

If calves are born during warm temperatures of 50ºF and above, there is no signal for BAT to generate heat. In this scenario, BAT differentiates to become WAT for later use by the animal in case of a nutrient shortage.

One of Smith's research projects examined Angus-Wagyu cows. One set of dams received restricted protein; another received proper amounts of protein. Limiting the dam's protein did not appear to affect the neonatal calf's BAT function or calf weight. The cow sacrificed her internal energy source and muscle for her calf's survival. However, more calves from thin mothers fail to survive cold, wet conditions than those from well-nourished dams.

"Anything producers can do to maintain good nutrition for the cow will result in a healthier calf," Smith advises. "It just makes sense that if the cow is well fed, the calf will be healthier and have more BAT."

Some cattle breeds, including Hereford and Angus (*Bos taurus*) have more BAT than Brahman cattle, with *Bos indicus* genetics. Brahman calves do not survive well in cold climates. Research shows that Brahman and Angus calves maintain identical lipid amounts in warm temperatures.

However, marked differences appeared when researchers moved calves to cold chambers. The calf's sympathetic nervous system detected cold, starting the sequence of events for BAT function. Angus calves maintained their BAT lipid supplies, while non-shivering thermogenesis kept them warm.

Conversely, Brahman calves placed in cold chambers had little lipid remaining after 48 hours, running out of "fuel." Smith compares this difference in metabolism to a Maserati sports car and Ford sedan. The Brahman or Maserati races through fuel, but the Angus or Ford utilizes energy more efficiently, traveling longer on one tank of fuel.

Brahman cattle do well in India's rare short-term chilly spells; however, they have not adapted to withstand prolonged frigid temperatures. As a result, these calves blast through their energy supplies to stay warm. They thrive in warmer regions, such as Southwestern or Gulf Coast states.

Some experts believe calves with good BAT stores survive the labor and birthing process easier. "If the dam received a quality diet, the calf will have adequate BAT supplies and will be a healthier calf," Smith advises. "Steer away from the *Bos indicus* influence if these calves will be born in cold environments. Ranchers could have serious calf loss, affecting the bottom line."

Shawn Archibeque, Ph.D., ruminant nutritionist at Colorado State University, says the immature nervous system of neonatal animals cannot start a shivering response. The shivering thermogenesis mechanism forces skeletal muscles to constrict and expand, which generates heat. The newborn's ability to dry off, warm up and raise its core temperature during wintry weather depends on how much stored body fat is available. Neonatal calves must rely on BAT to fuel non-shivering thermogenesis during the first few days of life.

"I was surprised by how strikingly different BAT is, from how it functions at a metabolic level to how it appears," Archibeque admits. "Its [brown color] is really distinct. This unique mechanism doesn't last long. Just long enough to help that young calf until it's able to shiver and generate heat to maintain its body temperature."

A primary benefit of BAT allows young animals to stay warm, particularly in colder climates. Archibeque says if they are born in south Texas, it is not a big deal. If they are born in late February to early March in Colorado, BAT is critical for survival.

"The point of this system is to metabolize fat and run all the biochemistry," Archibeque observes. "Instead of generating adenosine triphosphate [ATP], which is the energy currency of the cell, it lets it go. Uncaptured energy becomes heat. Calves burn a lot of fat quickly to create heat. From a production standpoint, that will not be sustainable in the long run."

Archibeque advises producers to make sure they are not limiting their cows' intake during the third trimester. That is the time to consider supplementation programs. It could be as simple as providing a product that stimulates greater intake of available forage or one that has non-protein nitrogen, which increases the digestibility of consumed forages. It also encourages eating more hay than normal. The cow will have more energy and protein to help support the fetus's growth and develop BAT deposits.

Jill Peine, ruminant support nutritionist with Ridley Block Operations, says the health and overall thriftiness of a newborn calf depend on the mineral and vitamin nutrition the dam received during the last trimester. Many of her trace minerals move to the fetal liver, stored for the calf to use after birth.

“Trace minerals are important for the calf’s immune function along with the dam’s quality colostrum once that calf is born,” Peine reminds producers. “Some other trace minerals, such as copper, are stored in the fetal liver; others may not be, but they are still essential for the calf’s health. The calf’s trace mineral levels may depend on the dam’s mineral status during gestation.”

Peine recommends feeding a mineral that meets the cow’s needs. It may differ from the summer mineral. Test forages to make sure they match the mineral and vitamin supplements to meet the herd’s requirements.

Antagonists, including iron or sulfur, bind minerals, rendering them less available to the animal. Chelated trace minerals are bound to a protein, making them more bioavailable.

“There are different mineral forms, such as organic chelated or inorganic trace minerals,” Peine concludes. “Organic trace minerals are more easily absorbed by the animal. Look at a partial replacement in the mineral formulation or total replacement with organic trace minerals.”