Beef Logic

by R.A. "Bob" Long

Basic genetics for cattlemen — Part I

All animals are composed of cells. The simplest, amoebas for example, are single-celled while the more sophisticated animals, such as humans and cattle, contain millions of cells. Regardless of the complexity or size of the organism, the basic design of each individual cell is essentially the same.

Cells are very small and can be seen only with a microscope. They vary tremendously in size, shape and function but are alike in basic anatomy. Check a child's biology textbook and find a drawing of a cell as seen under a microscope. Note that there is a "cell wall," which surrounds the entire cell. Inside this wall is the protoplasm (the living part of the cell), the all-important nucleus and some less-well-understood material such as mitochondria and Golgi bodies.

Since animals are made of cells, any growth, development or production must be the result of cell division. One cell divides to form two cells, two divide to form four, four produce eight and so on. *It is extremely important that cattle breeders understand there are two types of cell division — mitosis and meiosis.* Mitosis is the type of cell division by which animals grow, and meiosis is involved in reproduction. Both are essential for animal production but are very different and must be discussed separately.

Mitosis

Mitosis, or mitotic cell division, begins in the fertilized egg cell, or embryo. This embryo is formed in the reproductive tract of the cow by the union of an unfertilized egg produced by the female and a sperm cell from a bull. If the cow is normal and free of disease, this single cell begins to divide.

Within the cell is the nucleus, which contains the chromosomes. A chromosome is a large, complex organic molecule to which are attached many pairs of smaller molecules called genes. This genetic material controls the growth, division, differentiation and all biochemical processes of the cell — the very "stuff" of life itself.

As cell division begins, each new cell formed is an exact duplicate of the cell that formed it. After seven or eight days, the embryo is simply a mass of identical cells; then the wonders of cell differentiation begin. The how, why and when of cell differentiation are not understood, but they are controlled by the genetic material in the nucleus of the cell. At this time the embryo, or fetus as it is now called, forms three distinctly different types of tissue.

1. The ectoderm forms the nervous system (brain, spinal column and nerves) then further differentiates to form skin, hair and hooves.
2. The endoderm forms the lining of the digestive tract, lungs, liver, pancreas and bladder.
3. The mesoderm forms the body or carcass of the animal, part forming the skeleton; part, the muscles; and part, the fat cells.

Transformation

Approximately 283 days after fertilization the calf is born. The genetic material in the original fertilized egg, 50% of which came from the dam and 50% from the sire, determined the design, construction and potential of this calf.

The many various cells forming this calf are different in size, shape and function. They also vary widely in rate and time of growth. For example, cells lining the respiratory, digestive and reproductive tracts are continually replaced throughout life and can be completely renewed in a few days. However, all nerve and muscle cells have been formed at birth and continue to function until death.

Remember, in spite of this variation, the nucleus of each cell and the genetic material within it are identical throughout an individual animal. Further, assuming adequate nutrition and freedom from disease, the animal's growth rate, body composition, fertility, structure, behavior, instincts, response to environment or any other trait is dictated by that genetic material. The complexity of the physiological mechanisms controlled by this genetic material is mind-boggling and understood by no one.

Measuring differences

The goal of performance testing is to measure the genetic differences between animals. Legitimate performance records must be recorded among contemporaries. The cattle compared must be of the same sex and age, reared at the same time and place, and fed and managed identically. This permits the identification of those animals whose genetic potential is best-suited to the particular environment under which the test was conducted. Therefore, the environment used for performance testing must be identical to that under which the progeny of the cattle being tested will be expected to perform.

My next column, "Basic genetics for cattlemen — Part II," will deal with the other type of cell division known as meiosis. Meiosis is involved in reproduction. It is equally complex but must be understood if cattle breeders are to realize genetic improvement.

We Welcome Your Input!

Our Beef Improvement section has been expanded to include more information for today's performance-minded breeder. Both "Beef Logic" by Bob Long and the "What's Your Beef?" columns serve as a forum for Angus breeders and industry experts to express their opinions on current issues and topics of breed improvement and performance programs.

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