Unravelling some of the "genome" technology

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On the surface, cattle breeding still happens the same as it always has. However, the tools available to the producer making the critical decisions today have never been more complex. With advances in genetic technologies, you will have heard terms used and wondered about their meaning and application to your decisions in setting breeding objectives. Let's make an attempt at unravelling the "barbed-wire" surrounding the genetic make up of an animal that has some similarities to the two strands of wire that frequently coil up at some time in a fencing career!

Each characteristic of an animal is controlled by a string of protein molecules joined together in a distinctive pattern referred to as a gene. Many genes are linked together to form a chromosome. Genotype is the set of genes found within an organism's cells. A genome is all the DNA in a complete set of chromosomes. In all body tissues, the chromosomes are found in pairs within the nucleus of each cell. Each species has different numbers of chromosomes with cattle having 30 pairs of chromosomes. Humans have 23 pairs; 46 in all: 44 autosomes and two sex chromosomes. These chromosomes are threadlike "packages" of genes and other DNA in the nucleus of a cell. Deoxyribonucleic acid or DNA is the chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms. Each parent contributes one chromosome to each pair, so progeny get half of their chromosomes from their dam and half from their sire.

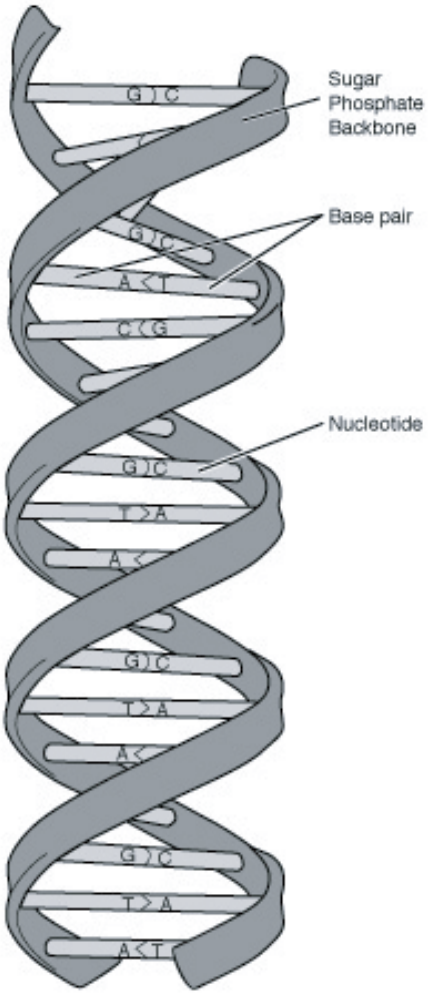
The structural arrangement of DNA or "double helix" looks something like an immensely long ladder twisted into a helix, or coil. The sides of the "ladder" are formed by a backbone of sugar and phosphate molecules, and the "rungs" consist of nucleotide bases joined weakly in the middle by hydrogen bonds as shown in the attached figure.

Two base pairs form a "rung of the DNA ladder". A DNA nucleotide is made of a molecule of sugar, a molecule of phosphoric acid, and a molecule called a base. The bases are the "letters" that spell out the genetic code. In DNA, the code letters are A (adenine), T (thymine), G (guanine), and C (cytosine) which are chemicals. In base pairing, adenine always pairs with thymine, and guanine always pairs with cytosine.

A "nucleotide"' is one of the structural components, or building blocks, of DNA and RNA (ribonucleic acid). A nucleotide consists of a base (one of four chemicals: adenine, thymine, guanine, and cytosine) plus a molecule of sugar and one of phosphoric acid.

A "marker", also known as a DNA marker or possibly like "a sign post" on the chromosome, is a segment of DNA with an identifiable physical location on a chromosome whose inheritance can be followed. A marker can be a gene, or it can be some section of DNA with no presently known function. Because DNA segments that lie near each other on a chromosome tend to be inherited together, markers are often used as indirect ways of tracking the inheritance pattern of genes that have not yet been identified, but whose approximate locations are known. Microsatellite (type II marker) is a type of marker made up of a simple pattern of nucleotides repeated over and over. Single Nucleotide Polymorphisms (SNPs) are another form of DNA markers.

The appearance and performance of an animal is determined by the pattern of proteins (genes) and thereby the genetic make-up of an animal or genotype. Multiple genes may collectively influence a trait which is the characteristic we record or measure in an animal. Therefore the more markers that are closely aligned to genes on the chromosome, the greater opportunity we have to more effectively make selection decisions that will meet our desired breeding objectives. At some point in time, as the number of identified markers increases, there will be a time when the costs associated with finding additional markers will not return an equal additional benefit of increased animal performance. Therefore an optimal number of markers for any particular trait may describe the majority of variation in that trait.



Beef CRC research has identified a number of markers that have already been commercialised for Marbling, Tenderness and Net Feed Intake. Current research is identifying additional markers for reproductive, adaptive and various welfare traits. The commercially reported values for any DNA marker show one of three variables e.g. not present, one copy or two copies of the gene are present. The future of genetic selection will lie in the combination of marker technology in association with Estimated Breeding Values (EBVs) as marker assisted EBVs.