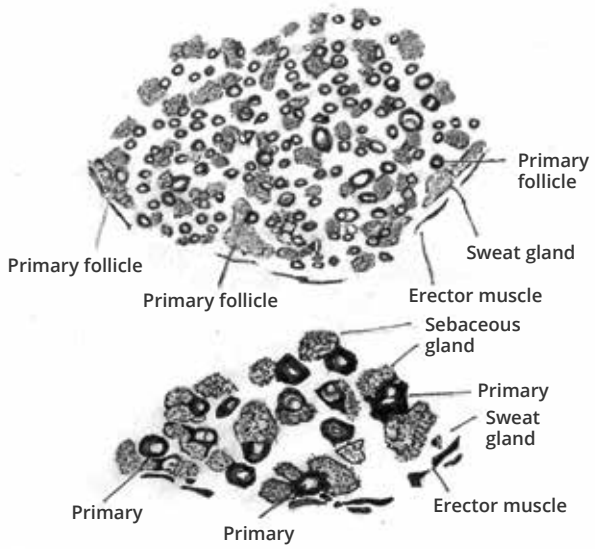
FACT SHEET

The Science Behind SRS®

Beginnings

There are two types of wool follicles in the sheep's skin (Figure 1) which are different in appearance and function. Primary fibres produce the outer coat of the newborn lamb. The secondary fibres form the undercoat, and represent the majority of fibres in the fleece. The follicles are arranged as clusters called follicle groups with 3 primary follicles per group and a larger number of secondary follicles.



The assumption has often been made that if we know the mean diameter of the fleece fibres, the primary fibres and the secondary fibres will have about the same diameters. This is incorrect. Primary fibres can range from being about 10 microns coarser to about 8 microns finer than the secondary fibres. In other words, and as shown by Jackson et al (1988), the diameters of the primary fibres and secondary fibres are to a large degree, independently genetically regulated.

Both traditional breeding programs for Merino sheep and scientifically designed breeding programs based on selection for fleece weight and mean fibre diameter have either been unaware or ignored this biological reality. Consequently, in all of these breeding programs there is direct evidence that primary fibre diameter has increased and has often led to loss of wool quality.

Figure 1 (left): *Illustrations of the arrangements of the primary and secondary follicles in a follicle group in the sheep's skin (as seen in horizontal skin sections under the microscope) of a high density Merino (top) and low density Merino (bottom)*

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The Science Behind SRS®

The SRS® Breeding System

The SRS® Breeding System involves selection of any fleece-coated animal, albeit a Merino sheep, an alpaca, an Angora goat etc. for low primary fibre diameter and high levels of fibre density and length.

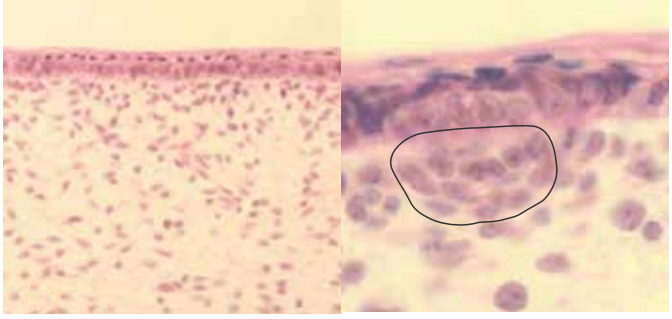
The system is based on the pre-papilla cell hypothesis of wool follicle formation and fibre size, first published by Australian scientist, Dr. Phillip Moore, in 1984. He proposed that pre-papilla cells in the foetal skin regulate wool follicle formation and fibre size. Another important discovery which is linked to the pre-papilla cell hypothesis was announced by Dr. Neville Jackson and co-workers in 1988 is that the genetic regulation of follicle development and fibre growth differs between primary and secondary wool follicles

It was Dr. Jim Watts' discovery in 1988 that the fibre bundle, and not the staple, is the basic unit of fleece structure that enabled a new sheep breeding system (SRS®) with new visual selection markers and measurement systems to be developed.

The Building Blocks of SRS®

1. Pre-papilla Cells

Pre-papilla cells differentiate from fibroblasts that reside in the foetal dermis. From about 65 days after conception, the pre-papilla cells aggregate into equally spaced clusters of genetically predetermined sizes. Each cluster stimulates above it the multiplication of epidermal cells that grow down into the dermis to form a wool follicle. The cluster of pre-papilla cells eventually reside in the dermal papilla (dp) at the base of the follicle *(Figures 2 & 3)*.



The first wave of follicles to form are primary follicles (P). The process is repeated for the original secondary (SO) follicles from about 80 days of gestation. A third wave of follicle development occurs from about 100 days when derived secondary follicles (SD) develop as branches of the original secondary follicles. SD follicles share a common opening at skin level through which about 3-4 fibres, on average, emerge.

The number of pre-papilla cells in the dermal papilla cells of a follicle is directly related to the diameter of the fibre produced by the follicle. Consequently, if small clusters of pre-papilla cells form, many follicles producing fine fibres develop. Conversely, if large clusters of pre-papilla cells form, fewer follicles producing coarser fibres will develop. It is analogous to emptying a bucket of water with a ladle. If a small ladle is used, many scoops are needed to empty the bucket. If a large ladle is used, fewer scoops are required. This sequence of events in the foetal skin of the Merino is illustrated in Figure 4.

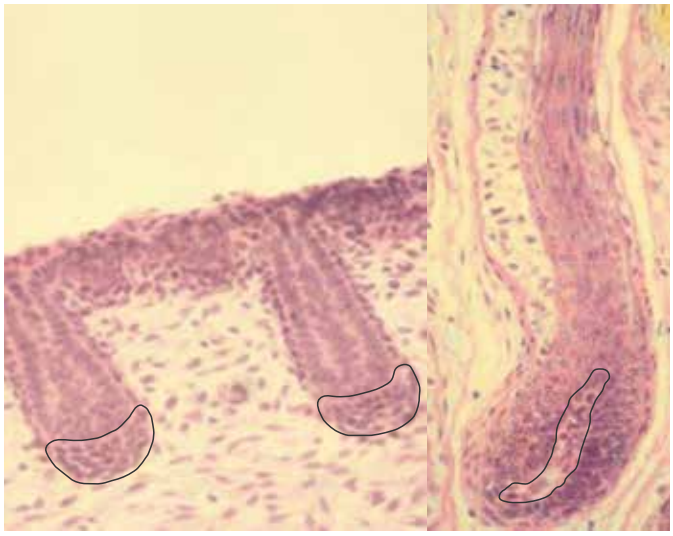


Figure 2 (left): *Left: At day 60 of gestation, the dermis of the foetal lamb skin contains collagen producing cells called fibroblasts. There are no pre-papilla cells present. Right: From day 65 onwards, pre-papilla cells, which have differentiated from fibroblasts, aggregate (shown by grey lines) at the dermal-epidermal interface.*

Figure 3 (above): *Left: The rapidly multiplying epidermal cells descend into the dermis with the pre-papilla cell cluster. Right: The dermal papilla is formed at the base of the wool follicle, enclosing the pre-papilla cluster.*

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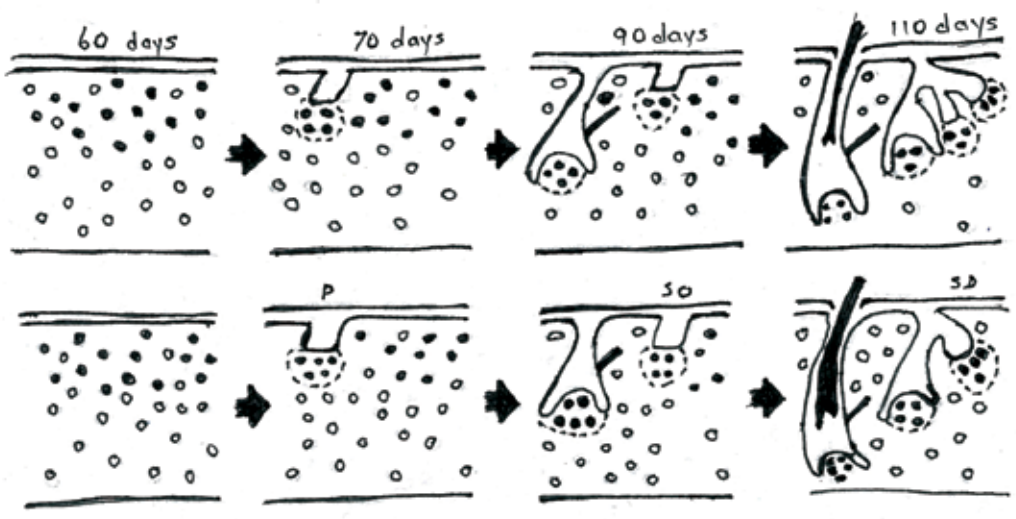

Figure 4 (left): *Diagrammatic representation of the distribution of pre-papilla cells (closed circles) in the foetal skin of a sheep which develops a high density of fine diameter fibres (above) and one that develops a low density of coarse diameter fibres (below).*

The closed circles are pre-papilla cells which differentiate from the collagen producing fibroblasts (open circles).

P = primary follicles;
SO = secondary original follicle;
SD = secondary derived follicle.
(Adapted from Moore et al, 1998).

SRS® sheep also appear to have larger starting populations of pre-papilla cells than other sheep (Watts and Ferguson, unpublished data). Fibre length appears to be determined by the 'signal strength' of the dermal papilla cells. A specific protein produced by the dermal papilla cells has been isolated and characterised (Moore, unpublished data). It acts as a mitogen, stimulating the turnover of follicle bulb cells. The stronger the signal, the greater is the production of follicle bulb cells which are destined to form fibre. Conversely, if the signal strength is weak, short fibres result.

2. The Fibre Bundle and Follicle Density

When follicle density increases, it is often as a consequence of more secondary follicles being laid down in each follicle group (with little or no increase in follicle group size) and the follicle groups being more closely packed to each other. This has the effect of reducing the distance between the wool follicles to a degree where the cluster of fibres originating from each follicle group are so well-aligned that it can be seen separately in the sheep's fleece *(Figure 5).* This cluster of fibres is called a "fibre bundle".

Figure 5 (above): *The fleece structure of the SRS® Merino. Sire Calcaling 382 Compression resistant test results was 2.5kpa which equates to twice as soft as the average cashmere.*

So, in a Merino sheep with a fleece composed of fibre bundles with each fibre bundle containing high numbers of wool fibres and the fibre bundles closely packed to each other, the animal is found to have very high density (at least 85 follicles per square millimetre) and is recognized as an SRS® Merino (provided its fibre length is also high).

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3. Fibre Length with Fibre Density

SRS® breeding programs have shown that Merino sheep can grow at least twice the fleece length of traditionally selected sheep, and this can occur in sheep with high fibre density *(Figure 6).*

Figure 6 (above): *Top: 8 months growth 120mm 17.3 Micron Parkdale Ram. Bottom: 5 Karbullah Rams lining up for the future sale, Lamb drop of 2022 at 11months old*

4. Thin and Loose Skin

Thin and loose skin is a feature of SRS® sheep *(Figure 7).* But why you ask? As indicated above, pre-papilla cells develop from fibroblasts. Fibroblasts produce collagen which is the main 'filler substance' of the skin. If the fibroblast population is depleted by large numbers of pre-papilla cells forming in the foetal dermis, less collagen is laid down and the skin is likely to be thin whilst large numbers of follicles are formed. There is a strong and negative genetic correlation (-0.77) between fleece length and body wrinkle. In other words, if Merino sheep are bred for long wools, the animals will be plain bodied and free of skin wrinkle. Wrinkle free skins are thin skins. Conversely, if Merino sheep are bred for short wools, the animals are likely to be thick skinned and wrinkly.

Figure 7 (above): *SRS® Merino sheep have thin and loose skins*

Contact Us

For more information on the SRS® Breeding System or sourcing SRS® Genetics please contact:
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