

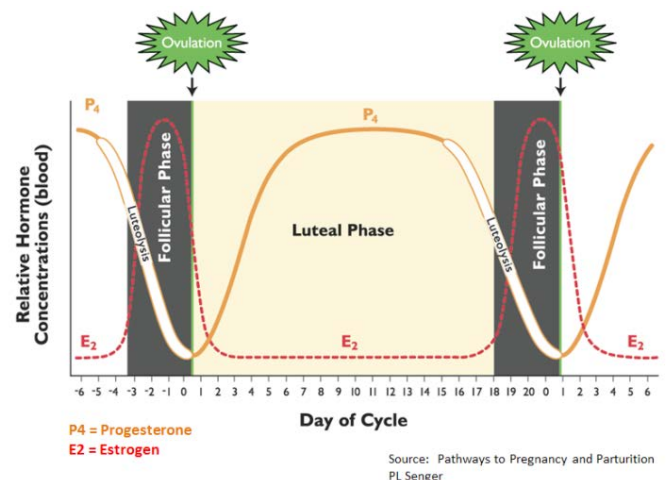
DAIRY COW IMMUNITY IMPACTS REPRODUCTIVE PERFORMANCE

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Impaired reproductive performance of dairy cows can have significant impact on the profitability of dairy operations. The immune system has been shown to play a role in dairy cow reproduction, both indirectly, through the effects of mastitis, metritis, retained placenta, and metabolic diseases; and directly, through actions of immune cells upon the ovary. A properly-functioning immune system may help improve reproductive performance of dairy cattle by reducing occurrence of diseases affecting fertility, and improving immune cell activity.

REVIEW OF DAIRY COW REPRODUCTION

The cow's estrous cycle is approximately 21 days long. It is divided into two phases which are characterized by changes on the ovary. The follicular phase makes up 20% of the cycle. During this phase the pre-ovulatory follicle on the ovary, which contains the oocyte (or egg), produces estrogen. When estrogen concentrations are high enough, a surge of luteinizing hormone (LH) is released, initiating ovulation. The luteal phase begins after ovulation, when the follicle transforms into a corpus luteum (CL) which produces progesterone to maintain pregnancy. This phase makes up the remaining 80% of the estrous cycle.



Reproductive performance is monitored using several metrics:

Calving Interval	Period between calvings
Days Open	Period between calving and confirmed conception
Services Per Conception	Total services per total number of pregnant cows
Heat Detection Rate	Percent of eligible cows that are bred
Conception Rate	Percent of cows bred that are pregnant
Pregnancy Rate	Percent of cows eligible to become pregnant that are confirmed pregnant during a given period (usually 21 days)

Reproductive performance is affected by both breeding success and pregnancy loss. Typically, gestation lasts 280 days. Up to 40% of pregnancies are lost in first 17 days of gestation. Early embryonic loss occurs from 0 to 15 days of gestation, and is usually not detected since pregnancy loss at this stage does not delay estrus. Late embryonic loss occurs at 16 to 41 days of gestation, and will delay ovulation and thus extend the estrous cycle. Embryonic losses usually occur before pregnancy is confirmed. Abortion occurs between 42 to 260 days of gestation, and stillbirths occur from 260 days of gestation through birth. "Normal" abortion rates are 3% to 5% per year.

INDIRECT EFFECTS OF DISEASE ON REPRODUCTION IN DAIRY COWS

Mastitis is associated with: increased Days Open^{1,2}; greater Services/Conception²; reduced Conception Rate^{3,1}; reduced Pregnancy Rate^{4,1}; higher incidence of Early Embryonic Death^{5,6}; and greater risk of abortion^{7,1}. Infection of the udder affects the structure and function of the ovaries⁸ and has also been associated with altered patterns of reproductive hormone secretion⁴. These effects may be linked to a systemic response by cytokines⁹ (molecules released by cells that affect actions of other cells, particularly immune cells) which may also lead to pregnancy loss¹⁰.

Retained placenta can also have indirect effects upon fertility, including: reduced Conception Rate³; lower Pregnancy Rate¹¹; more Services per Conception¹²; and increased Days Open¹³. Retained placenta is associated with reduced neutrophil function and lower blood concentrations of interleukin-8¹⁴ (IL-8, a cytokine that attracts immune cells to sites of infection), and may alter activities of the CL¹⁵.

Uterine disease, which includes metritis (inflammation of the entire uterus) and endometritis (inflammation of the uterine lining), is associated with: lower Conception Rate¹⁶; reduced Pregnancy Rate¹¹; and increased Days Open¹⁷. Uterine disease appears to have the greatest impact on fertility by reducing ovulation rate¹⁸ and CL size¹⁹ during the first post-partum estrous cycle. Cows with uterine disease also have smaller follicles and lower blood estrogen concentrations²⁰. Cows that develop uterine disease experience reduced neutrophil function around the time of calving^{21,22}.

Metabolic diseases are also associated with impaired reproductive performance.

- Milk fever increases Days to 1st Service¹¹
- Subclinical hypocalcemia reduces 1st Service Conception Rate²³
- Ketosis increases Days to 1st Service & decreases 1st Service Conception Rate¹¹
- Mastitis combined with other diseases has greater negative impact on reproduction than any one disease alone²⁴

IMMUNE CELLS PLAY A DIRECT ROLE IN REPRODUCTION

Immune cells, primarily neutrophils, macrophages, and T-lymphocytes, are required by the ovary for normal ovulation and CL function²⁵. Activities of these immune cells are regulated by the luteal environment, and result in both CL development and regression²⁶. Neutrophils migrate into the early CL (day 1 to 4 of the estrous cycle), in response to IL-8 produced by the CL. Neutrophil numbers and IL-8 concentrations are low at the mid- and late-luteal phase but IL-8 is high at luteal regression. Interestingly, cortisol (a potent, immunosuppressive hormone released in response to stress) acts to block the release and peak of LH from the pituitary gland, which can prevent ovulation.

The immune system has both direct and indirect effects upon reproduction in dairy cows. Reproductive performance may be improved with a properly-functioning immune system.

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