

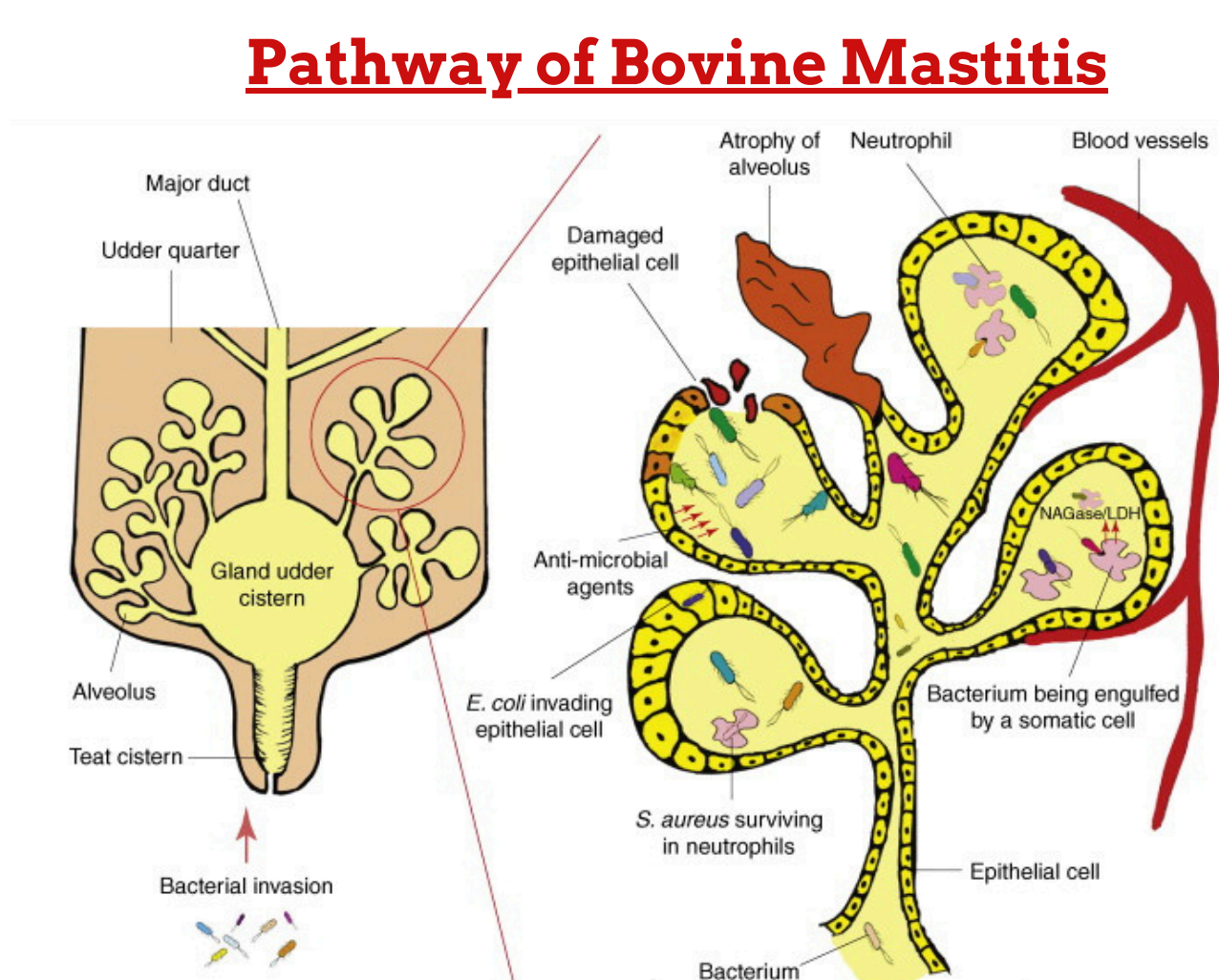
# Vitamin E and Selenium Supplementation for the Prevention of Bovine Mastitis



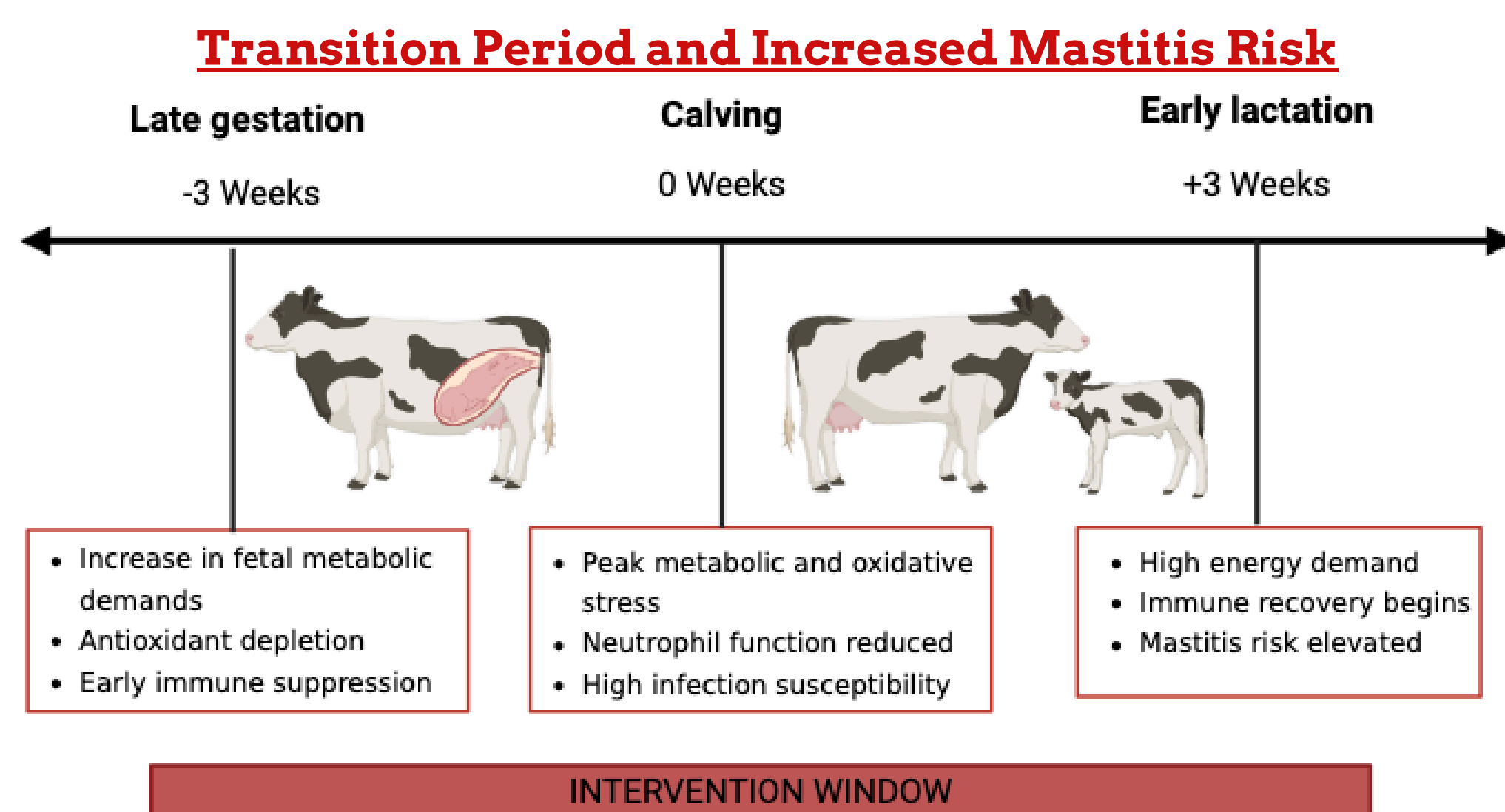
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TBIOMD 492

## Introduction

- Mastitis, inflammation of the udder, is responsible for reduced milk quality, decreased fertility, and 60–70% of antibiotic use on dairy farms.
- During the periparturient period (figure 2), cows experience oxidative stress and immune suppression, increasing susceptibility to intramammary infection.
- Pathogens like *E. coli* and *S. aureus* invade through the teat canal (figure 1), triggering inflammation.



**Figure 1.** Pathogenic bacteria invade the mammary gland by overcoming immune defenses, including the teat sphincter and mammary epithelium. Inflammatory signaling then recruits neutrophils to eliminate invading pathogens such as *Escherichia coli* and *Staphylococcus aureus* during mastitis development.



**Figure 2.** Physiological changes during the periparturient period increase susceptibility to mastitis in dairy cows. Elevated metabolic demands, oxidative stress, and immune suppression occur during late gestation and early lactation, creating a critical window for vitamin E and selenium supplementation. Created with BioRender.com.

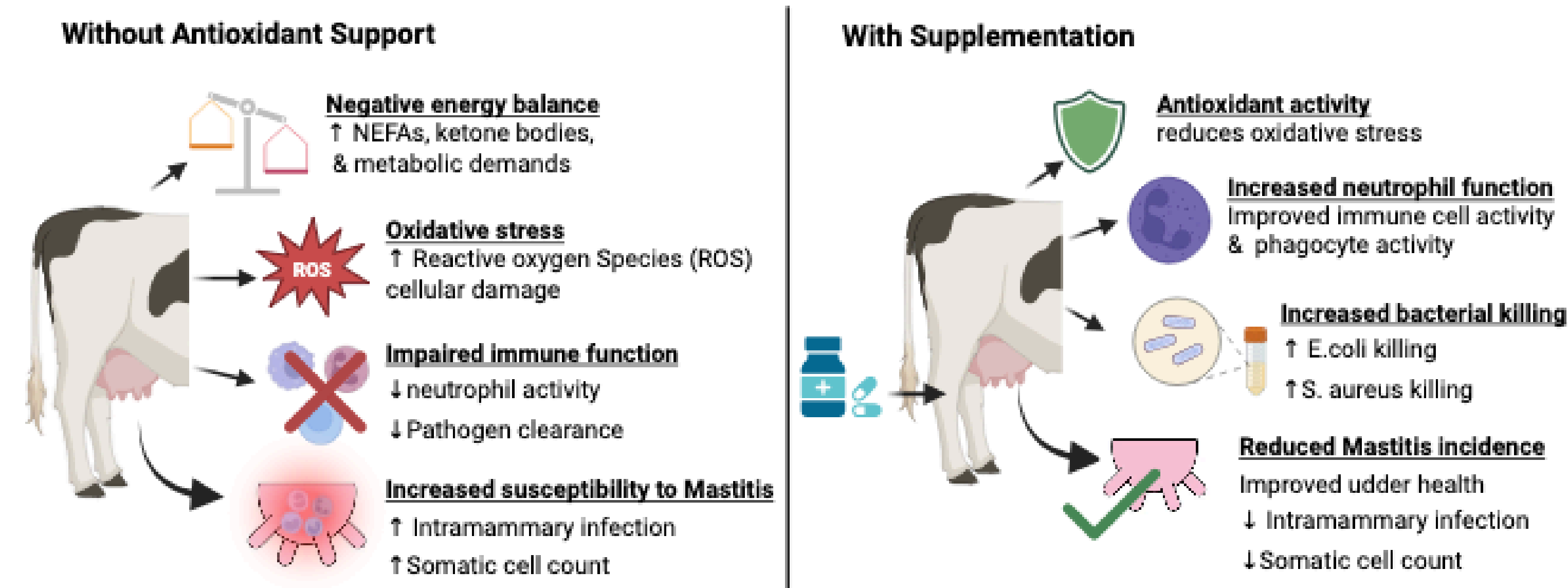
- Oxidative stress during the transition period impairs neutrophil-mediated immune defense in the mammary gland. Together, they work as an antioxidant pair, strengthening immune defenses during periods of increased oxidative stress.
- Vitamin E and selenium individually function as antioxidants that support immune cell activity and reduce oxidative damage.
- Supplementation during the periparturient period may improve bacterial clearance and reduce mastitis incidences.

## Methods

- The literature review focused on 33 peer-reviewed studies, including randomized controlled trials (n = 9), clinical studies (n = 17), and mechanistic research.
- Outcomes evaluated included mastitis incidence, somatic cell count (SCC), neutrophil bacterial killing, and immune function.
- Most supplementation protocols provided vitamin E and selenium daily through feed or mineral mixtures during the periparturient period.

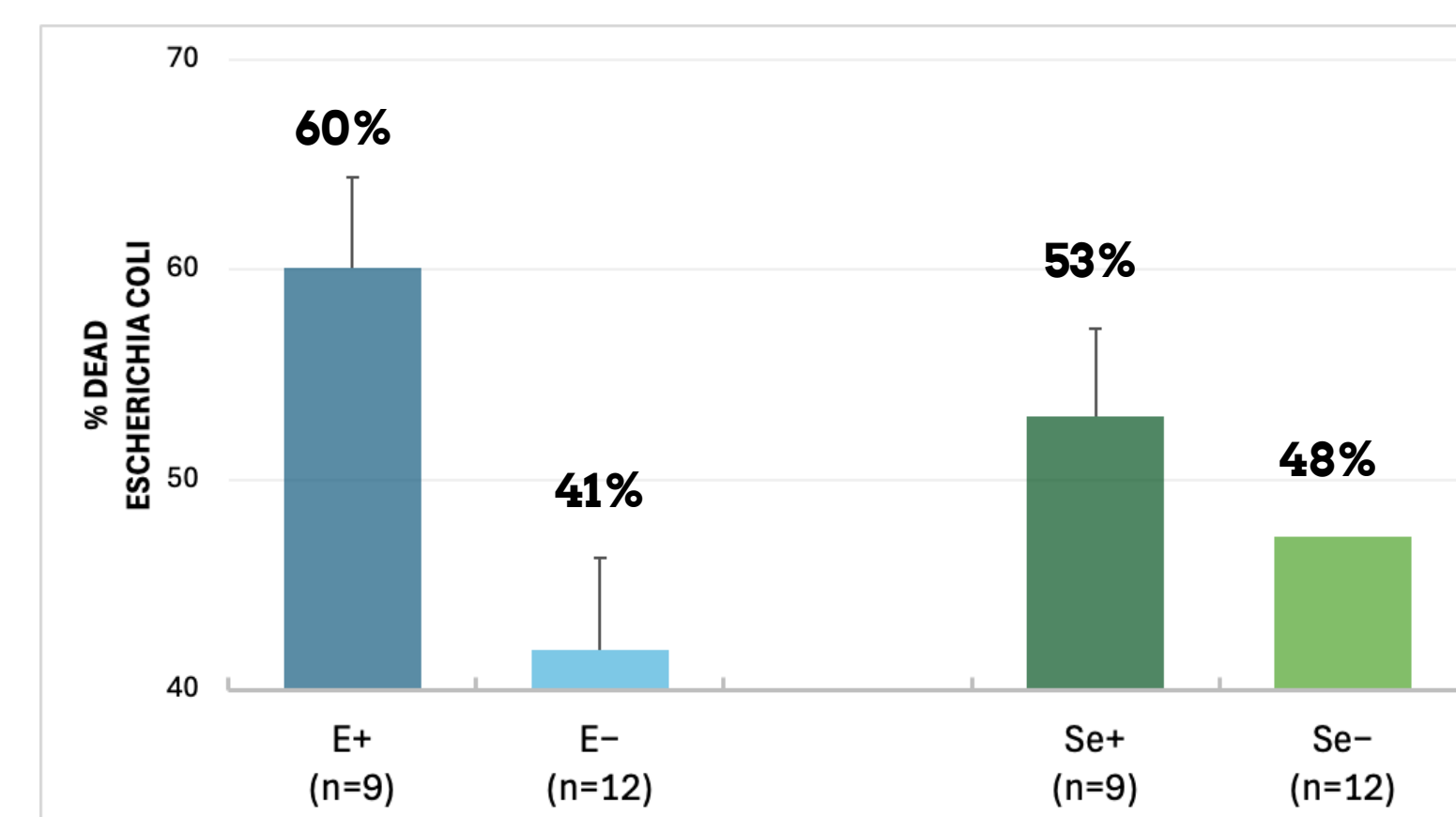
## Results

### Proposed Mechanism of Vitamin E and Selenium Protection



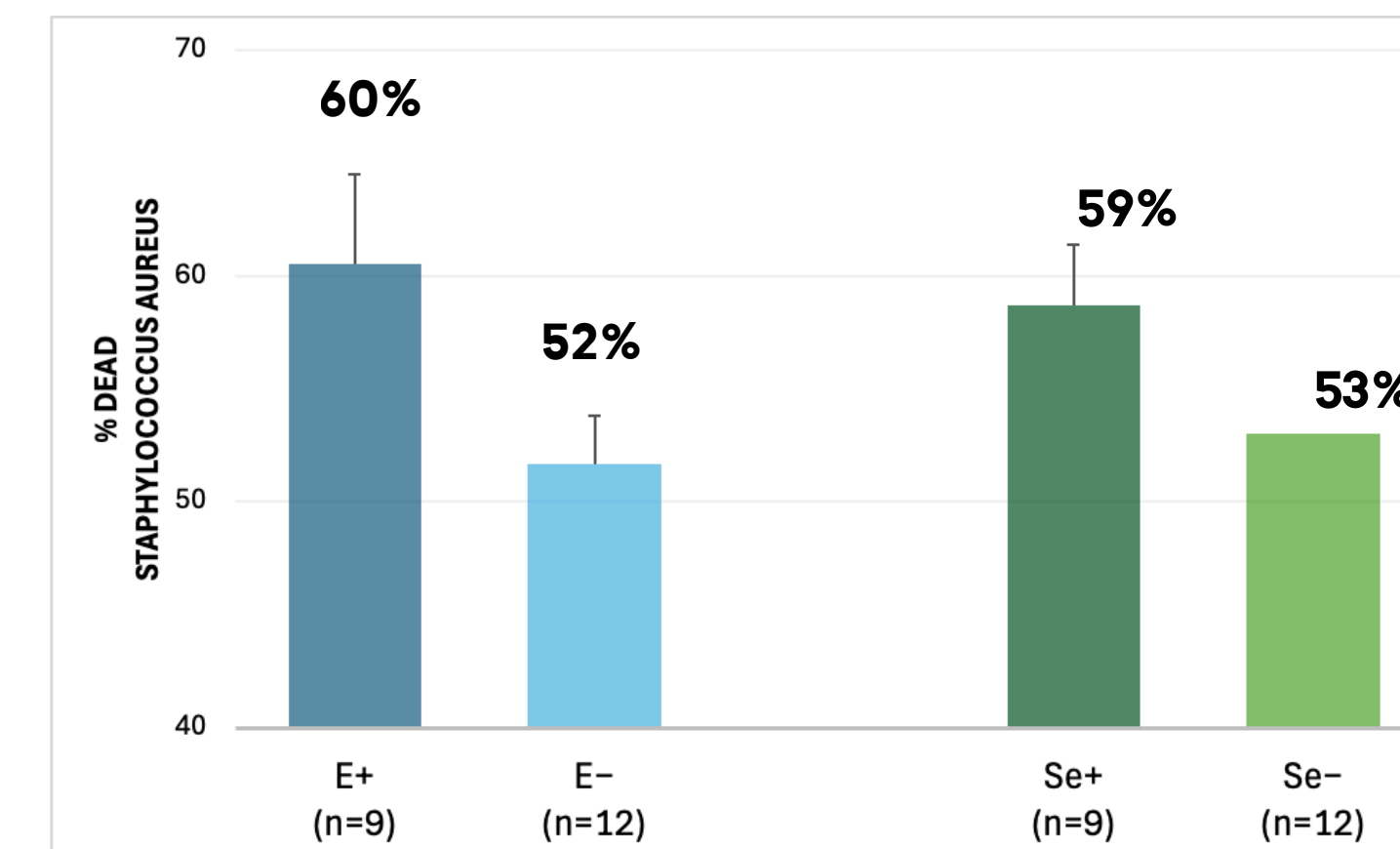
**Figure 3.** Periparturient timeline of mastitis susceptibility and the proposed mechanism which vitamin E and selenium supplementation reduce mastitis risk in dairy cows. Created with BioRender.com

### Enhanced Neutrophil Killing of *E. coli*



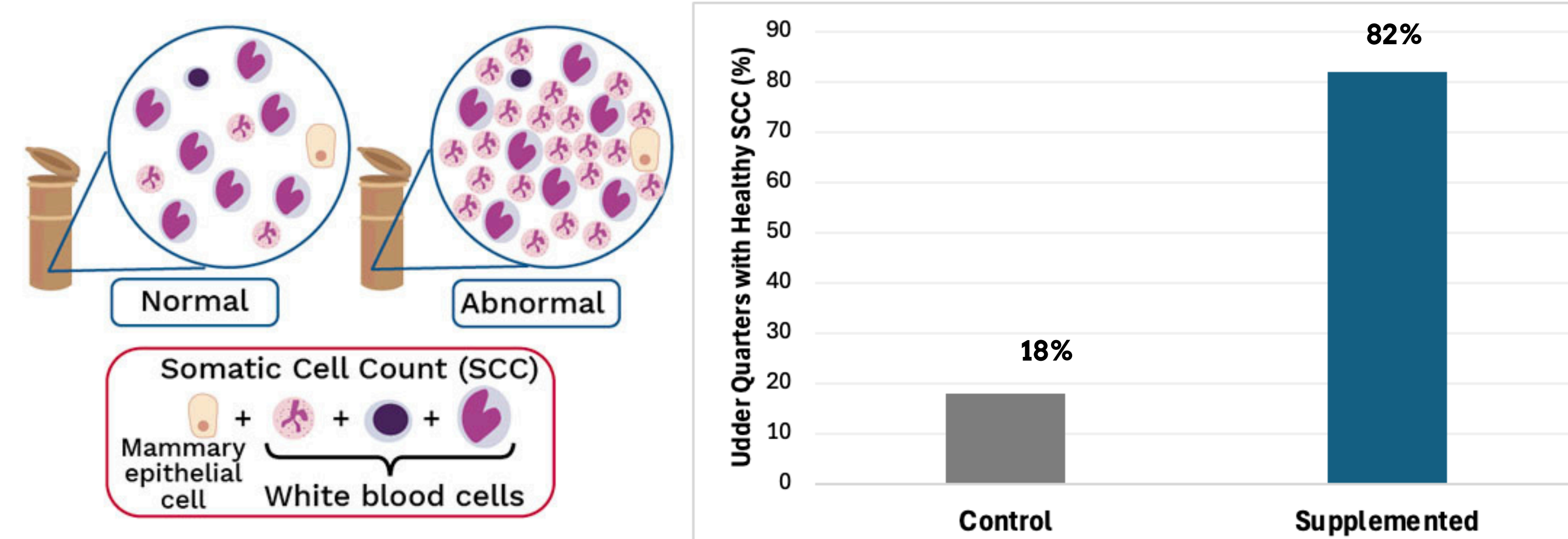
**Figure 4.** Intracellular killing of *E. coli* by bovine neutrophils following vitamin E and selenium supplementation. Supplemented groups exhibited higher bacterial killing percentages than unsupplemented controls, indicating enhanced immune function during the transition period. Graph created in excel

### Enhanced Neutrophil Killing of *S. aureus*



**Figure 5.** Intracellular killing of *S. aureus* by bovine neutrophils following vitamin E and selenium supplementation. Improved bacterial killing suggests greater pathogen clearance capacity in supplemented cows. Graph created in excel.

### Reduced Somatic Cell Count Following Vitamin E and Selenium Supplementation



**Figure 6.** Somatic cell count (SCC) outcomes following vitamin E and selenium supplementation. SCC reflects the concentration of leukocytes and epithelial cells in milk and is commonly used as an indicator of mammary gland inflammation. Approximately 82% of udder quarters from supplemented cows remained below the mastitis-associated threshold (<500,000 cells/mL), compared with only 18% of quarters from control cows, indicating improved udder health and reduced susceptibility to mastitis. Adapted from Devi and Dutta (2018).

## Quick Facts

- U.S. dairy producers lose over \$2 billion annually due to mastitis.
- Clinical mastitis incidence is highest within the first 2 weeks postpartum.
- Somatic cell counts > 500,000 cells/mL are commonly associated with mastitis-related inflammation.
- Subclinical mastitis often occurs without visible symptoms and is detected through laboratory testing.

## Key Findings

- Vitamin E supplementation increased neutrophil intracellular killing of both *E. coli* and *S. aureus*.
- Selenium supported antioxidant defense mechanisms and immune cell function.
- Supplemented cows exhibited lower somatic cell counts and reduced susceptibility to intramammary infection.
- The greatest benefits occurred during the periparturient period when immune suppression and oxidative stress are highest.

## Significance

- Vitamin E and selenium supplementation represents a practical nutritional strategy for improving udder health and reducing mastitis risk.
- Improved immune function may reduce disease incidence, enhance milk quality, and decrease reliance on antibiotic treatment in dairy herds.

## Future Directions

- Investigation of postpartum supplementation and its effect on recurrence
- Further characterization of oxidative stress and immune signaling pathways involved in bovine mastitis progression
- Improvements in supplementation dosage and timing
- Investigation of combined antioxidant and micronutrient therapies to reduce antibiotic dependence
- Further characterization of the host-pathogen interactions and immune signaling pathways within the mammary gland during mastitis development (figure 1)

## Aknowlegements

I would like to sincerely thank Dr. Chivese for his mentorship, guidance, and continued support throughout this project, and Dr. Heller for her valuable insight and encouragement during the development of my work.

