J.N. Andrews Honors Program
Andrews University

Proposal for Senior Honors Thesis

HONS 497 Senior Honors Thesis **Credits 2** (2 minimum required)

Directions: Please return signed proposal to the Honors Office **at least one week prior to your scheduled meeting with the Honors Council**. This proposal must be accepted by Honors Council the semester before presentation.

Student's Name: Jared Wallen

Primary Advisor: Katherine Koudele
Secondary Advisor:
Thesis Title: Monitoring the Immune Status of Calves at the Agriculture Education Center
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Targeted Semester for Poster/Final Thesis: Spring 2022
Expected Semester of Graduation: Spring 2022

I. Provide goals and brief description of your project or research.

Unlike humans, animals do not receive immunoglobulins (Ig's) transplacentally *in utero:* they receive them in the colostrum, the first milk. The calf receives these Ig's has whole molecules during a 24-hour window after birth when the small intestine is able to absorb them. The transfer of Ig's in the colostrum to the calf is termed "passive transfer." If the calf does not receive the colostrum in the first 24 hrs after birth the Ig concentration in the blood is too low and does not provide protection from pathogens. Ideally the colostrum should be fed in the first 6 hours after birth. (Figure 1).

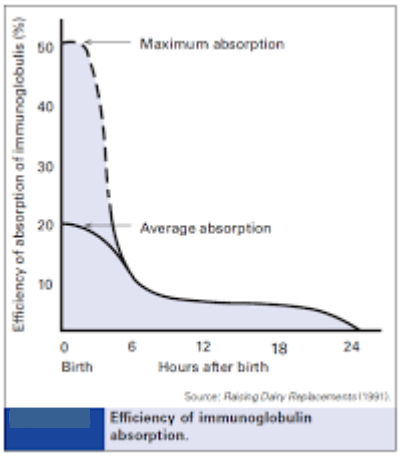

Figure 1 The efficiency of immunoglobulin absorption by the neonatal calf. *(https://www.extension.iastate.edu/dairyteam)*

At about 2 weeks of age, the calves' active immunity will start developing and the passive immunity (PI) will begin weakening. (Figure 2). Passive immunity is crucial because if they do not receive PI they will not have any immunity until their active immunity develops. Active immunity is the natural immunity developed over time due to exposure to different pathogens.

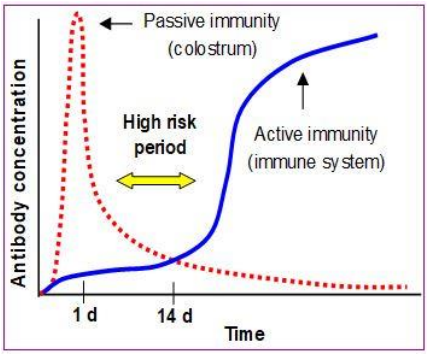

Figure 2: The transition from passive immunity to the development of active immunity in calves. *(https://www.alltech.com/blog/calving-considerations-3-tips-early-nutrition)*

The calves in this study will be housed at the A.U. Agriculture Education Center (AEC). They will be composed of two populations: 1) the calves born to resident cows and 2) the purchased calves. Those calves which are born at AEC are expected to show higher levels of serum immunoglobulins since they will have received their colostrum in a timely manner and have not experienced the stressors that the purchased calves will have experienced. The purchased calves will come from a large dairy farm about 1.5 hours from the AEC. The stressors that these calves will experience include 1) possibly not receiving colostrum within the first 6 hours after birth, 2) traveling via trailer, 3) a new environment (people, animals, surroundings), and 4) possible exposure to different pathogens/diseases. The stress experienced by the calves will weaken their immune systems increasing morbidities (Hulbert and Moisa).

The goal of this research project is to correlate the relationship of immunoglobulin (Ig) levels in the blood of the young calves, both resident and purchased, at the Agriculture Education Center (AEC) and their health status during the 8-week period they are fed milk.

II. Outline your methodology. **Please be specific**. How does this achieve your goals and how reliable is it?

Each fall semester calves from two different sources are raised by the Animal Science students at the A.U. Agriculture Education Center: those born to the resident cows and those born at another farm and brought here. The calves born at the AEC will be weighed and monitored from the time they are born. For these calves, the blood will be drawn within the first week following parturition (birth). For the purchased calves, the blood will be drawn from the time they arrive. After the initial blood draw, the blood will be taken weekly for 8 weeks to determine immunoglobulin G (IgG) levels. IgG immunoglobulins are the most prevalent in cattle blood. IgG levels will be measured using bovine IgG ELISA kits produced by ABclonal (https://abclonal.com/) . Bovine IgG ELISA kits have a sensitivity of 1.245 ng/ml, a range of 3.125 ng/ml – 100 ng/ml, the sample type can be plasma or serum, and the detection method is colorimetric. Data collected from the calves will include weekly blood for Ig level analysis, daily rectal temperatures, daily milk and grain intake, weekly body weights, and any incidence of disease such as diarrhea or pneumonia. This data will be analyzed to determine any correlation of health status/morbidity and serum immunoglobulin levels in the calves. All other health indicators will be recorded when the calves are cared for twice daily.

By correlating the IgG levels with health indicators, it will be possible to determine if there is a pattern to when the calves are getting sick. The expectation is that there will a higher rate of sickness at about two weeks of age. If there is a pattern to calf morbidity, further research can be conducted to ascertain the cause or causes. Thus, when combined with the other indicators of calf health, I will be able to diagnose morbidity with a high level of certainty.

III. Explain in what sense your project is original, unique, or beyond normal senior expectations. How does it relate to current knowledge in the discipline?

This project stems from my work with the animals at the Agriculture Education Center. In our work with animals, specifically the young calves, we have found that they tend to get sick at about two weeks of age. This is not unusual in calves due to their development of active immunity. This has been studied extensively, but my goal is to monitor our purchased and native calves and to collect data pointing to any possible correlation of illness. This project will use information and skills I have developed over a variety of classes including collection of blood samples, analysis of blood samples, documentation of animal behavior, and other related skills. Thus, my project will go beyond normal senior projects by looking at qualitative and quantitative data as well as including skills and information learned from many classes. My project is original because I will be working with animals at the new Agriculture Education Center doing a case study that could lead to further research in the field.

IV. Include a substantive annotated bibliography of similar or related work.

Chase, C. C., Hurley, D. J., & Reber, A. J. (2008). Neonatal immune development in the calf and its impact on vaccine response. *The Veterinary clinics of North America. Food animal practice*, *24*(1), 87–104. https://doi.org/10.1016/j.cvfa.2007.11.001
This research article focuses on calves' immunological response as the calves develop and the components of passive

immunity. The article discusses the effects of maternal immunity on how calves develop specific immunity and vaccine strategies for developing protection against pathogens in calves. The research performed in this article follows a similar path I plan to perform in my research. This article states the importance of colostrum in passive immunity, "The ingestion of colostrum is essential for providing neonates with immunologic protection during at least the first 2 to 4 weeks of life." I plan to test the level of immunoglobulins in calves throughout development and the pathogens in their blood. This will allow me to compare the calves' passive immunity and active immunity and the time in between.

Filteau, V., Bouchard, E., Fecteau, G., Dutil, L., & DuTremblay, D. (2003). Health status and risk factors associated with failure of passive transfer of immunity in newborn beef calves in Québec. *The Canadian veterinary journal = La revue veterinaire canadienne*, *44*(11), 907–913.
This study was done to determine risk factors associated with failure of passive transfer immunity (FPT). Physical exams were performed on normal calves and blood samples collected for measurements of serum concentration of immunoglobulin (Ig) G_1. They found that calves born in a stanchion-stall were more likely to shows FPT. They also found the cold-stressed may have a slower rate of intestinal absorption and may also be reluctant to stand and suckle voluntarily but birth month was not associated with FPT. The final consideration mentioned was that of quality calf environment and management practices, and monitoring dams' BCS. This provides further information as to possible causes for calf sickness in Andrews University calves. These are factors that must be considered if some of the calves have FPT.

Hulbert, L. E., & Moisá, S. J. (2016). Stress, immunity, and the management of calves. *Journal of Dairy Science*, *99*(4), 3199–3216. https://doi.org/10.3168/jds.2015-10198
This article describes the study of different types of weaning methods used and how it may impact a calf's oral behavior pre-weaning. Calf stressors are important to understand to reduce morbidity and mortality. This article also studied commingling strategies and nutritional supplements that may help with the transition from individual to group housing. The aim of this article was to optimize calves' health and well-being at the early stages of life to improve their long-term health and welfare. I will use this article as supplemental material in studying stressors and how Andrews University calves are handled in order improve our methods. I will study how our calves develop passive and active immunity and determine stressors in their early environment and how those stressors can be reduced to maintain their health.

Lombard, J., Urie, N., Garry, F., Godden, S., Quigley, J., Earleywine, T., McGuirk, S., Moore, D., Branan, M., Chamorro, M., Smith, G., Shivley, C., Catherman, D., Haines, D., Heinrichs, A. J., James, R., Maas, J., & Sterner, K. (2020). Consensus recommendations on calf- and herd-level passive immunity in dairy calves in the United States. *Journal of Dairy Science*, *103*(8), 7611–7624. https://doi-org.ezproxy.andrews.edu/10.3168/jds.2019-17955
This study brought together various academic, extension, and industry specialists in the calf health arena to discuss the evaluation and possible revision of the Transfer of Passive Immunity (TPI) for dairy calves. 4 different options were evaluated with a different number of categories. The option selected separated calves into 4 different risk groups depending on their IgG levels. These groups <10.0 g/L, 10.0 to 14.9 g/L, 15.0 to 19.9 g/L, 20.0 to 24.9 g/L, >25.0 g/L. These were rated as poor, fair, good, and excellent, respectively. This article is important to my research because it will inform me as what how healthy the calves at the AEC are based on their IgG levels. These standards are for dairy calves as that is the area in which the article was focused, however, it does mention the TPI levels for beef calves as well. These are: >24 g/L or <24 g/L. Failure of passive transfer (FPI) has been generally labeled as <10 g/L.

Lora, I., Gottardo, F., Contiero, B., Dall Ava, B., Bonfanti, L., Stefani, A., & Barberio, A. (2018). Association between passive immunity and health status of dairy calves under 30 days of age. *Preventive Veterinary Medicine*, *152*, 12–15. https://doi.org/10.1016/j.prevetmed.2018.01.009
In this study, Italian dairy cattle were observed to evaluate the association between passive immunity and health status within 30 days of age under field conditions. Blood serum samples were taken for the assessment of Ig and fecal samples were taken to determine bacteria present. They found that FPT showed in increased risk of diarrhea and mortality. Low passive immunity levels were also associated with early age onset of disease and potentially the need for antibiotic treatment for recovery. This article serves as a source for my research because it shows the importance of proper passive transfer. From this research, I can know that decreased Ig's in the AEC calves is a significant indicator of morbidity.

Priestley, D., Bittar, J. H., Ibarbia, L., Risco, C. A., & Galvao, K. N. (2013). Effect of feeding maternal colostrum or plasma-derived or colostrum-derived colostrum replacer on passive transfer of immunity, health, and performance of preweaning heifer calves. *Journal of Dairy Science*, *96*(5), 3247–3256. https://doi.org/10.3168/jds.2012-6339
This article studied the effects of different types of colostrum. The forms studied in this trial were maternal colostrum, a plasma-derived colostrum, or colostrum-derived colostrum. At birth calves were assigned different groups and then were tested for things such as serum total protein, serum IgG concentrations, apparent efficiency of absorption, and mortality rates. Given the conditions of the trial, maternal colostrum was found to be superior. This trial can inform my research as to the most effective types of colostrum and what benefits they may have. This can then be applied to Andrews University calves for better health.

Trotz-Williams, L. A., Leslie, K. E., & Peregrine, A. S. (2008). Passive Immunity in Ontario Dairy Calves and Investigation of Its Association with Calf Management Practices. *Journal of Dairy Science*, *91*(10), 3840–3849. https://doi.org/10.3168/jds.2007-0898
This article studies the effects of farm techniques such as calf management and details of colostrum feeding. The numbers of serum total protein in calves were used to compare the effects of the management techniques. The results

showed serum TP ranging from 3.5 to 9.8 g/dL. This implied management techniques could affect the passive transfer of maternal immunity. This is important for my research because it shows how external factors can be applied to improve calf and reduce the chance of risk of failure of passive transfer (FPT).

Poulsen, K. P., Foley, A. L., Collins, M. T., & McGuirk, S. M. (2010). Comparison of passive transfer of immunity in neonatal dairy calves fed colostrum or bovine serum-based colostrum replacement and colostrum supplement products. *Journal of the American Veterinary Medical Association*, *237*(8), 949–954. https://doi.org/10.2460/javma.237.8.949

This study was done to test to the effects on the transfer of passive immunity when using bovine serum-based colostrum replacement and colostrum supplement products as compared with natural colostrum. The study included 287 neonatal heifer calves from 8 different farms. The study found that the calves that received natural colostrum had significantly higher levels of IgG and total protein levels as compared with the calves that received the colostrum replacement and colostrum supplement. No difference was detected between calves that received adequate levels of passive transfer of immunity. This article informs my research by describing and articulating the adequate levels of passive transfer of immunity. It also describes the effects of supplemental or replacement colostrum should the AEC ever need to use it.

Todd, C. G., McGee, M., Tiernan, K., Crosson, P., O'Riordan, E., McClure, J., Lorenz, I., & Earley, B. (2018). An observational study on passive immunity in Irish suckler beef and dairy calves: Tests for failure of passive transfer of immunity and associations with health and performance. *Preventive Veterinary Medicine, 159*, 182–195. https://doi-org.ezproxy.andrews.edu/10.1016/j.prevetmed.2018.07.014

This study was performed to evaluate the tests used to determine failure of passive transfer based on calf health and performance and to describe the epidemiology of morbidity and mortality in suckler beef and dairy calves under Irish conditions. The results showed that calves with lower passive immunity test results are at a higher risk of experiencing a negative health event or poor performance. It also found that passive immunity test results were lower for beef calves than for dairy calves. This further informs my research regarding the results of failure of passive transfer and effect is has on calves. It also shows that beef calves have a higher incidence of failure of passive transfer than dairy calves.

Lee, S.-H., Jaekal, J., Bae, C.-S., Chung, B.-H., Yun, S.-C., Gwak, M.-J., Noh, G.-J. and Lee, D.-H. (2008), Enzyme-Linked Immunosorbent Assay, Single Radial Immunodiffusion, and Indirect Methods for the Detection of Failure of Transfer of Passive Immunity in Dairy Calves. Journal of Veterinary Internal Medicine, 22: 212-218. https://doi.org/10.1111/j.1939-1676.2007.0013.x

The goal of this study was to determine the agreement between the Enzyme-Linked Immunosorbent Assay (ELISA) and single radial immunodiffusion (SRID) and to compare the diagnostic performance of ELISA with indirect methods, in detection of failure of passive transfer. 115 dairy calves were observed from 23 calf-rearing facilities. The agreement between SRID and ELISA was 94%. The supports my research because it shows the accuracy of the ELISA test which I will be using to test for IgG's in the calves blood.

V. Provide a statement of progress to date and list the research methods coursework completed.

To date, my preparation for this project includes developing calf management skills and sickness detection in a variety of livestock at the AEC. The classes I have taken that relate directly to this project include:

ANSI 305	Animal Nutrition
ANSI 114	Intro to Animal Science
AGRI 345	Livestock Health & Disease
ANSI 325	Domestic Animal Behavior
ANSI 440	Animal Reproduction
AGRI 335	Research Methods
HONS 398	Research Pro-seminar

Department Chair Approval

- ☐ **This student's performance in his/her major field is acceptable.**
- ☐ **He/she has completed the requisite research methods coursework for the research to be pursued.**
- ☐ **I understand that he/she plans to graduate with Honors.**

Katherine Koudele
Department Chair (signature required)

Research Advisor Approval

I have read and support this proposal: Katherine Koudele
Primary Advisor (signature required)

I have read and support this proposal: _____

Secondary Advisor (signature required)

If human subjects or if live vertebrate animals are involved, evidence of approval from the Institutional Review Board or an Animal Use Committee is needed through the campus scholarly research offices (Ext. 6361).