Effects of Artificial Light on Gut Inflammation in Songbirds

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Introduction

Natural day/night cycles are fundamental environmental cues that influence organismal physiology and behavior. The widespread prevalence of artificial light at night (ALAN) has disrupted these cycles, leading to mistimed endocrine activity and heightened stress responses in vertebrates such as songbirds. To investigate the effects of these environmental changes on the gastrointestinal inflammation, I am comparing the intestinal lining histopathology of young zebra finches (*Taeniopygia guttata)* exposed to ALAN with those reared under natural daily light/dark cycles. Recent data demonstrates that there are diurnal fluctuations in intestinal barrier integrity[1,2], implying that disruption of circadian regulation due to ALAN exposure may result in gut inflammation. This research is ongoing, and the results will provide insight into the avian gut-brain axis and the effects of artificial light on gastrointestinal health.

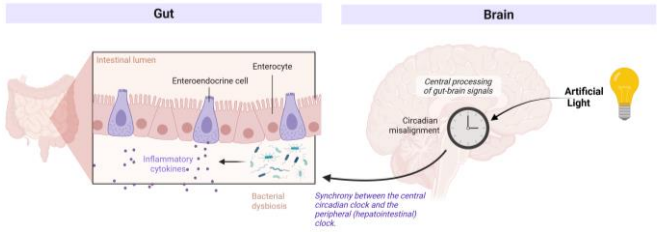

Figure 1. Proposed mechanism of how the neuroendocrine immune system is impacted by ALAN. (Created with BioRender.com)

Study Design

Twenty pairs of unrelated male and female zebra finches are being used in two treatments. In the experimental treatment, 10 mating pairs are exposed to short-wavelength light, which has been shown to increase corticosterone levels in songbirds (Grunst et al. 2020). Ten mating pairs will be assigned to a control treatment and exposed to a simulated 12-hour day/night cycle. The offspring will be raised under the same light treatment as the parents until independence. To assess the effects of ALAN on the offspring's microbiomes, I will:

- Evaluate proinflammatory cytokine levels (e.g., IL-6, TNF-α, IL-1β) within the intestinal wall of the colon by hematoxylin and eosin (H&E) staining and immunohistochemistry for T-cell markers (e.g., CD3, CD4, CD8).
- Quantification of immune cell infiltration and proliferation will be conducted using image analysis software to assess inflammatory responses in these tissues.

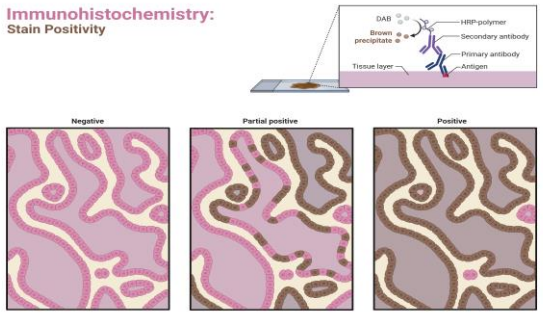

Figure 2. Demonstration of immuno-histochemistry staining for positive, partial positive, and negative results. (Created with BioRender.com)

Predicted Outcomes

I predict that ALAN-exposed birds will exhibit increased proinflammatory cytokine levels and T-cell infiltration consistent with a heightened proinflammatory state. This will be displayed through positive immunohistochemistry results, indicating a direct link between circadian rhythm disruption and inflammatory responses in intestinal tissues.

Future Research

Future work will center on microbiome composition during development of *T. guttata* offspring. Inflammation has been shown to drive gut microbial dysbiosis[3], However, it is unclear whether early exposure to environmental stressors like ALAN impacts microbiome formation and subsequent physiological fitness. To address these knowledge gaps, we hope to further investigate the relationship between ALAN exposure, inflammation, and the gut microbial diversity of zebra finches.

References:

Kyoko OO et al. 2014. PLoS One 9(5), e98016[1]. Swanson GR et al. 2016. Am. J. Physiol Gastrointest. Liver Physiol 311 (1). [2] Zeng MY et al. 2017. Mucosol Immunol 10(1). [3]

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