

# Seasonal Coat Color Changes in Arctic Animals and the Role of Daylight Duration

## INTRODUCTION

Arctic and sub-Arctic animals such as the Arctic fox, snowshoe hare, Arctic hare, ptarmigan, and ermine display remarkable seasonal coat color changes. This adaptation enables them to blend with their environment and survive harsh seasonal conditions. These changes are primarily regulated by daylight duration (photoperiod), not temperature.

## MECHANISM OF COAT COLOR CHANGE

### 1. Photoperiod Detection

Arctic animals detect seasonal changes in daylight through the eyes. Light signals travel to the suprachiasmatic nucleus (SCN), the biological clock, which measures day length. This allows the body to anticipate seasonal transitions.

### 2. Role of the Pineal Gland and Melatonin

The pineal gland secretes melatonin during darkness. Thus:

- Long winter nights → High melatonin.
- Short summer nights → Low melatonin.

Melatonin secretion patterns help the body determine the season.

### 3. Hormonal Regulation

Melatonin influences the pituitary gland, altering hormone release, especially prolactin.

- High prolactin (summer) → Brown coat.
- Low prolactin (winter) → White coat.

### 4. Gene Expression in Hair Follicles

Prolactin and melatonin regulate melanogenesis genes such as TYR, MITF, and DCT.

- Summer: Melanin production increases, resulting in brown pigmentation.
- Winter: Melanin production decreases, and unpigmented white hair grows.

## EXAMPLES OF ARCTIC ANIMALS

### 1. Snowshoe Hare

Changes from brown in summer to white in winter. Photoperiod is the primary trigger, but temperature and snow cover fine-tune the exact timing.

## 2. Arctic Fox

Shifts from a brown/gray coat in summer to a completely white coat in winter for perfect camouflage in snow-covered landscapes.

## 3. Ptarmigan

Undergoes molting of feathers with photoperiod-regulated hormonal control, switching from mottled brown (summer) to pure white (winter).

## 4. Ermine (Stoat)

Turns white except for its black tail tip in winter. The tail tip may confuse predators.

### ADAPTIVE SIGNIFICANCE

- Camouflage improves predator avoidance.
- Enhances hunting efficiency.
- White fur provides better thermal insulation due to its structural properties.
- Enables survival in environments with extreme seasonal shifts.

### CLIMATE CHANGE IMPACT

Coat color changes are controlled by photoperiod rather than temperature. As climate change alters snow cover patterns, many Arctic animals suffer camouflage mismatch:

- White animals on snowless ground face increased predation risk.

### SUMMARY TABLE

Season	Daylight	Melatonin	Prolactin	Coat Color	Melanin Activity
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Summer	Long days	Low	High	Brown	Active
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Winter	Short days	High	Low	White	Inactive
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### CONCLUSION

Seasonal coat color change in Arctic animals is a sophisticated adaptation controlled primarily by photoperiodic regulation of endocrine and genetic pathways. This mechanism allows animals to optimize camouflage and energy balance throughout the year.