



# WHAT CAN HORMONES TELL US ABOUT WILDLIFE HEALTH?

Jennifer Terry<sup>1\*</sup>, Alyssa Hartzheim<sup>2</sup>, Lorin A. Neuman-Lee<sup>1</sup> and Amy R. Pearce<sup>3</sup>

<sup>1</sup>Department of Biological Sciences, Arkansas State University, Jonesboro, AR, United States

<sup>2</sup>Departments of Molecular Biosciences and Clinical Sciences, North Carolina State University College of Veterinary Sciences, Raleigh, NC, United States

<sup>3</sup>Department of Psychology, Indiana University Indianapolis, Indianapolis, IN, United States

## YOUNG REVIEWERS:



TANUJ

AGE: 8



THAKSITA

AGE: 9

Since animals cannot directly talk to humans, scientists, veterinarians, and conservationists may use hormones to learn important things about animal health. Hormones are chemical messengers that are critical to life functions for animals and humans. These tiny messengers are produced in the body and released into the bloodstream. Hormones are found not only in blood, but also in traces animals leave behind, like fur, feces (poop), and feathers. In our human-influenced world, understanding how wild animals are affected by changes in their environments through measuring their hormones will aid in developing effective conservation strategies.

## HORMONE

A molecule produced by a cell or gland and released into the bloodstream, acting as a chemical messenger and causing changes in the body.

## CIRCULATORY SYSTEM

The system that moves blood throughout the body.

## METABOLITE

The leftover product of a hormone after it is broken down in the body.

## HOW ARE THE ANIMALS DOING?

Climate change, human-wildlife interactions, and loss of habitat are altering our world. Such changes also impact animals and influence their behavior, population sizes, and physical health [1]. These changes can ultimately lead to the extinction of animals [1]. To understand how to help animals, scientists and veterinarians need to understand what is going on inside their bodies. However, wild animals cannot directly tell us how they are doing, and getting them to the veterinarian is often difficult. Instead, scientists can use traces left behind by animals to understand their health. These traces, like hair, blood, poop, and even earwax, contain chemicals, such as **hormones**, that help us understand animals, even when they cannot tell us what is going on with them.

## THE BLOODSTREAM WORKS AS A HIGHWAY

The **circulatory system**, led by the heart, pumps blood throughout the body. Blood contains many things, like oxygen-carrying red blood cells and disease-fighting white blood cells. These cells allow organs to function and help the immune system to fight off potential illness. Blood also contains hormones—chemical messengers released from organs and glands into the bloodstream. The bloodstream acts like a highway for hormones, allowing them to travel to other parts of the body (Figure 1). Once they have reached their intended destinations, hormones then interact with cells, tissues, and organs if those structures have a specific receptor for that hormone. Simply put, the hormone acts as a key and the receptor acts as a lock; only the right key can fit! Hormones bind to receptors, and this action causes a cascade of changes. Effects of hormones vary by situation but can affect the whole body through the release of other hormones and changes in which proteins the body's cells make. Once hormones bind to their targets, hormones are broken down into **metabolites** and removed from the body.

Hormones are critical to life functions. For example, the hormone melatonin helps regulate the body's internal clock; cortisol and corticosterone help with energy use and can indicate responses to stress; and progesterone is associated with pregnancy [1, 2]. Much like Goldilocks and the three bears, hormone levels need to be "just right"—too much or too little hormone may keep the body from functioning properly. Because hormones cause a cascade of changes in the body, consequences of high or low hormone levels may include increased susceptibility to illness or failure to reproduce [2]. To determine if hormone levels are too low, too high, or just right, scientists and veterinarians must also look at other symptoms, like diseases or changes in behavior.

### Figure 1

Some hormones are released from glands into the blood stream. For example, cortisol is released from the adrenal glands on top of the kidneys. Cortisol is important for the body's normal functions, but too much or too little cortisol can be unhealthy. Hormones may be deposited into keratinized structures such as hair by passive diffusion, and released in excretions such as feces (Image created using BioRender).

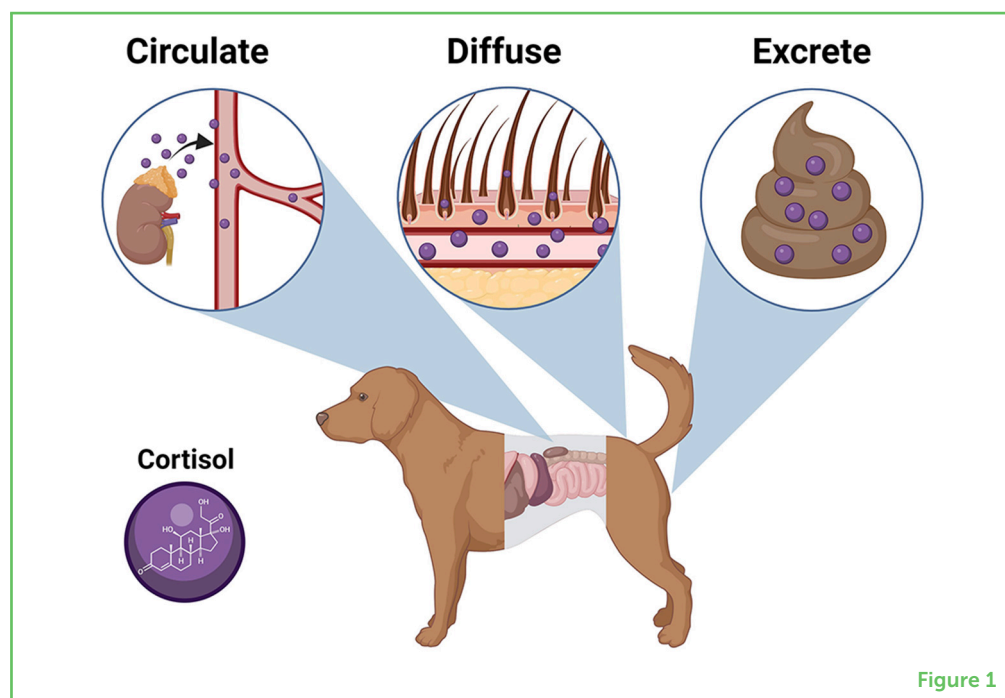


Figure 1

## HOW CAN WE FIND HORMONES?

A doctor or veterinarian may do bloodwork on their patients to check hormone levels as part of a health exam. For example, if you are feeling unusually tired, your doctor may look at your thyroid hormone levels to see if your thyroid is functioning properly. **Hypothyroidism** occurs when the thyroid gland does not produce enough thyroid hormones. Hypothyroidism can also occur in animals, like a pet dog! Hormone testing from blood work can provide evidence of hormone problems and allow doctors and veterinarians to give patients the proper treatment.

However, scientists can also find hormones in other things that animals leave behind. This is particularly helpful if animals are rare or difficult to locate, if not enough blood can be safely collected, or if animals are very sensitive to human contact. Hormones can be found in **keratinized materials** like nails and hair [3]. As these structures grow, hormones are deposited in them from the nearby blood supply by **passive diffusion** (Figure 1) [3]. Hormones in their metabolite form can also be passed into **excretions** like feces (poop), urine (pee), and saliva (spit). For critters like frogs, scientists can even use the water they live in to measure hormones from the animal. Egg-laying moms also deposit hormones into their eggs, which can reveal a lot about both mom and baby. Scientists can use the same hormone analysis methods, regardless of whether the sample is blood, feces, or feathers. These different kinds of samples provide specific “snapshots” of hormone levels (Figure 2). For example, a blood sample represents hormones at the exact second of blood collection, a poop sample

### HYPOTHYROIDISM

Condition that occurs when not enough thyroid hormone is produced in the body.

### KERATINIZED MATERIALS

Body structures that contain a substance called keratin, which is part of nails, hair, scales, and feathers.

### PASSIVE DIFFUSION

The movement of a substance, like a hormone, across cells or tissues without the need of energy, a special transporter, or regulation.

### EXCRETIONS

Substances produced to eliminate wastes from the body, such as feces (poop), urine (pee), or sweat.



represents hormone levels within the last hours or days, and a nail sample represents hormone levels within weeks or months.

Figure 2

Non-blood sources of hormones may vary by animal. Keratinized materials and excretions can be collected from live animals or from existing museum specimens. For example, baleen (found in the mouth and helps with eating) and earwax can be collected from whale specimens in museums. Scutes, or the top layer of shells, can be collected from turtles. Eggs can be collected from egg-laying mammals like the platypus (Image created using BioRender).

|            |                                                                                                      | Circulate      | Diffuse                                                 | Excrete                                            |
|------------|------------------------------------------------------------------------------------------------------|----------------|---------------------------------------------------------|----------------------------------------------------|
| Mammals    | <br>Tiger           | Found in blood | Found in whiskers, nails, fur, eggs, baleen, and earwax | Found in feces, saliva, and urine                  |
| Reptiles   | <br>Desert Tortoise |                | Found in scutes, nails, scales, and eggs                | Found in feces, saliva, and urine                  |
| Amphibians | <br>Western Toad    |                | Found in skin secretions, feces, and eggs               | Found in skin secretions, feces, saliva, and urine |
| Birds      | <br>Green Jay     |                | Found in feathers, nails, and eggs                      | Found in feces, saliva, and urine                  |
| Fish       | <br>Rainbow Trout |                | Found in scales and eggs                                | Found in feces and urine                           |

Figure 2

## HOW CAN HORMONE KNOWLEDGE HELP US CONSERVE ANIMALS?

When scientists collect samples from animals in the wild, they take these samples into the lab to measure hormone levels. By studying hormone levels, scientists can infer various things about the animal and the effects of its environment (Table 1). Hormone levels can reveal if animals may be affected by certain types of stress in their environments. The type of information gathered varies by animal and sample, but scientists have used this method in several ways to understand animal health. Knowledge of animal health can help scientists and conservationists to plan continuing conservation efforts and can alert scientists that animals may need help [2, 5, 7].



**Table 1**

Hormones can tell scientists about the general health and stress levels of various animals in need of conservation.

| Animal                                                         | Sample type      | Hormone                                    | Captive vs. Wild | Why                                                                                                                                            |
|----------------------------------------------------------------|------------------|--------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Short-beaked echidna                                           | Fecal            | Progesterone                               | Captive          | Tracking progression of pregnancy and health of the mother without needing to constantly take her to the veterinarian [4]                      |
| Northern pike, walleye, whitefish, white sucker, rainbow trout | Scale clipping   | Cortisol                                   | Wild, Captive    | Understanding long-term stress and getting a “normal” measurement of health in a less invasive way [5]                                         |
| Indian star tortoise                                           | Fecal            | Corticosterone                             | Captive          | Determining if there are changes in stress levels between seasonal indoor and outdoor housing, to see if there is a need to change housing [6] |
| Wyoming toad                                                   | Skin swab, Fecal | Corticosterone, cortisol                   | Captive          | Assessing effectiveness of reintroduction efforts and how they are coping with stress [7]                                                      |
| Yellow-eyed penguin                                            | Blood            | Corticosterone                             | Wild             | Assessing effect of tourism on stress levels—do tourists need to keep their distance [2]?                                                      |
| Orangutan                                                      | Urine            | Corticosterone                             | Wild             | Assessing effect of deforestation on development of facial features                                                                            |
| White rhino                                                    | Fecal            | Testosterone, progesterone, corticosterone | Wild             | Determining changes in stress and health following horn removal, to see if it is a safe way to prevent poaching [8]                            |

**Table 1**

While this article discussed how animal traces are used to measure hormones as a way to understand animal health, scientists can also measure other things animals leave behind. For example, [animal poop spreads seeds and provides nutrients for other organisms](#); [microbes in tapir poop helped scientists understand forest health](#); and [monarch butterfly wings helped scientists understand if parasites were related to wing deformities](#).

In summary, human impacts are changing the planet and affecting wildlife. Measuring hormones along with other indicators of individual and population health helps scientists understand how animals are coping in their environments. Hormones can be collected directly from the bloodstream or from the traces that animals leave behind, like scales, feces, and hair. Hormone research has helped improve

the welfare of both wild and captive animals and it gives us information about which animals need our protection and how we can conserve them.

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## AI TOOL STATEMENT

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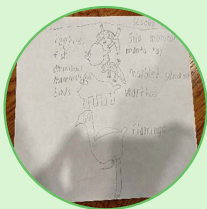
## YOUNG REVIEWERS

### TANUJ, AGE: 8

My name is Tanuj and I do not have a middle name. My favorite show and book is Scooby Doo. My favorite tradition is Halloween. I like to learn about animals. I am in 3rd grade. My favorite drink is icee and my favorite meat is Bacon and my favorite snack is marshmallow. In the future I want to set up a Scooby Doo Ghost Costume store. I like to play card games and Scooby Doo board games.

### THAKSITA, AGE: 9

Hi, my name is Thaksita and I am in 4th grade. I am 9 years old. Some of my favorite things are, gymnastics and reading. One fun fact about myself is I love Harry Potter. My favorite character is Hermione.





## AUTHORS

### JENNIFER TERRY

Jennifer Terry is a Ph.D. candidate in environmental sciences at Arkansas State University—Jonesboro. She earned her M.S. in biology from Arkansas State University and a B.A. in animal behavior from Bucknell University. Jennifer's research examines physiology and population dynamics in freshwater turtles. [\\*jenlaurterry@gmail.com](mailto:*jenlaurterry@gmail.com)



### ALYSSA HARTZHEIM

Alyssa Hartzheim is a medical laboratory technician at the North Carolina State University College of Veterinary Sciences. She earned her M.S. from Arkansas State University and her B.S. in zoology from North Carolina State University. Alyssa's passions delve into turtle biology and animal anatomy.



### LORIN A. NEUMAN-LEE

Lorin A. Neuman-Lee is an associate professor of physiology at Arkansas State University—Jonesboro. She earned her Ph.D. in biology from Utah State University, her M.S. in biology from Eastern Illinois University, and a B.S. in both English and biology from Iowa State University. Lorin's research examines physiology, particularly immune function, in reptiles and other vertebrates.



### AMY R. PEARCE

Amy R. Pearce is a teaching professor in the Department of Psychology and a STEM Education Innovation and Research Institute Associate at Indiana University Indianapolis. She earned her Ph.D. in neuroscience, plus a certificate in science communication from The Australian National University and her B.S. in psychology from Arkansas State University. Amy teaches neuroscience courses at her university and promotes STEM education through school and community events, including fun things like science comedy and science festivals.

