

## ● FIELD MUSEUM EXHIBITION LINKS

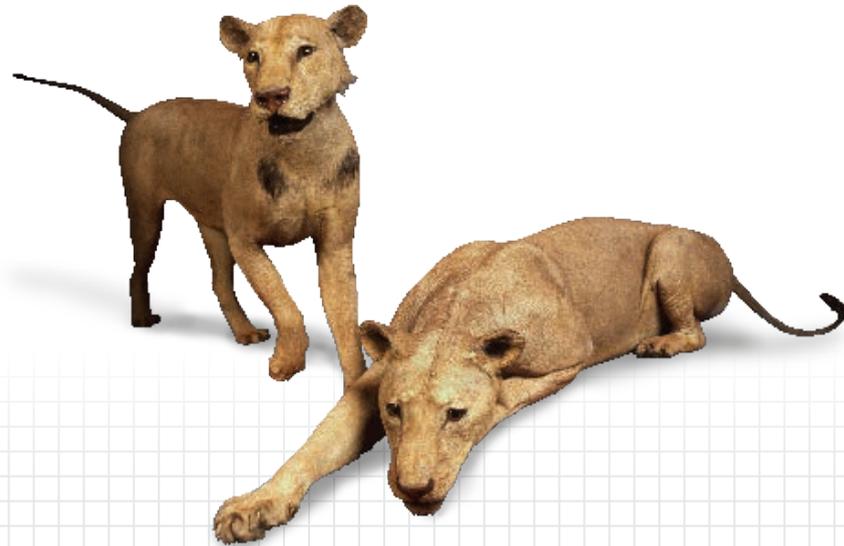
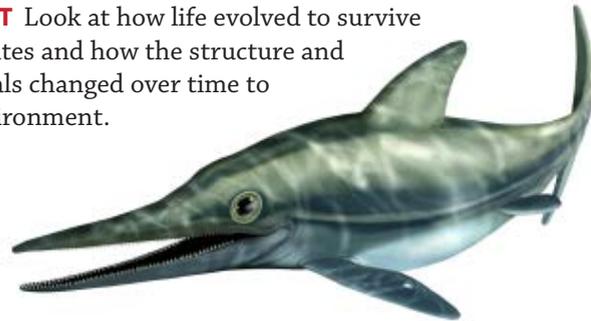
These permanent exhibitions at The Field Museum can connect directly to the *The Machine Inside: Biomechanics*. They can help spark new questions or allow students to apply new ideas they may have learned.

**WHAT IS AN ANIMAL?** Find animals whose unique skeletal structures help hold themselves up, learn about other senses that animals have, and more ways they can move around.



**RONALD AND CHRISTINA GIDWITZ HALL OF BIRDS** and **HALL OF AFRICAN MAMMALS** Study other animals and use what you learned from biomechanics to hypothesize if they are fast or hard biters, how they insulate or radiate heat, if they are fast or slow moving, and more!

**EVOLVING PLANET** Look at how life evolved to survive Earth's past climates and how the structure and function of animals changed over time to address their environment.



## ● NEXT GENERATION SCIENCE STANDARDS\*

The following NGSS standards are most closely addressed in the exhibition itself, though further connections could be made. NGSS standards are also defined in individual items in our multimedia toolkit.

### Content Alignment

**PS2.A Forces and Motion** (Elementary, Middle, and High School) – Though not explicitly discussed, there are numerous examples of Newton's Laws in action throughout the exhibition.

**PS3.A Definitions of Energy** (Middle and High School) – The exhibition has a gallery focused on how animals insulate themselves or radiate heat into the environment.

**PS3.B Conservation of Energy and Energy Transfer** (Middle and High School) – Within the exhibition, animals are constantly converting potential to kinetic energy through spring-like structures and materials.

**LS1.A Structure and Function** (Elementary) – Animals have a variety of structures that help them function in specific ways for survival, all within the laws of physics.

### Practice Alignment

**Asking questions and defining problems** – Within the exhibition text, questions are asked for visitors to think about. These can potentially inspire new questions.

**Developing and using models** – Examples of technology inspired by nature (biomimicry) are throughout the exhibition. These technologies rely on models of how animals or plants function.

**Planning and carrying out investigations** – Digital interactives ask visitors to test their ideas and review actual data taken by scientists.

### Crosscutting Concepts Alignment

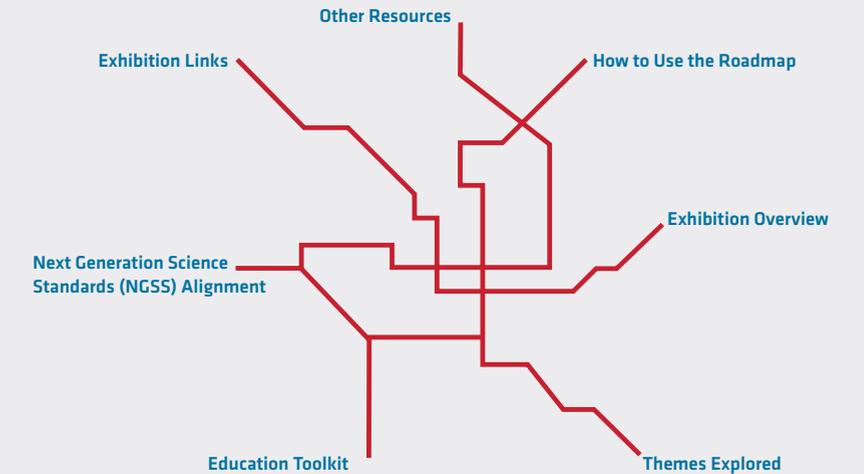
**Scale, proportion, and quantity:** The scale and size of different animals and plants affect properties such as bone size, heart structure, muscle density, and more necessary for survival.

**Structure and function:** Different materials are needed for different functions. The material itself and its shape can work together to help organisms survive in harsh conditions.



# The MACHINE INSIDE BIOMECHANICS

## EDUCATOR ROADMAP



*The Machine Inside: Biomechanics* was developed by The Field Museum, Chicago, in partnership with the Denver Museum of Nature & Science.

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THE CHICAGO  
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## ● HOW TO USE ROADMAP

This is a device to help you figure out how the topic of biomechanics, the study of nature through the lens of physics, can fit into your **middle or high school** curriculum.

## ● THEMES EXPLORED

### Structure and Function

- How do different structures help life function?
- What forces of nature is life exposed to and how do different structures function to resist these forces?
- How do different structures help absorb or store energy?



### Forces

- What are the different ways animals generate force?
- For what purposes does an animal generate force?
- What are the tradeoffs between force, speed, and motion sustainability?



### Energy

- How do animals store, absorb, or release energy for different purposes?
- What are analogous mechanisms for energy storage and absorption?



## ● EXHIBITION OVERVIEW

Every living thing is a machine built to survive through evolution. See where physics and biology meet!

### CHAPTER 1: BUILT TO SURVIVE

Explore how different structures help life survive, that pressure is an integral part of life, and how animals maintain their temperature in these three galleries.

### CHAPTER 2: BUILT TO MOVE

Discover how wing and fin shape affects an animal's movement through air and water and how animals store energy. Three galleries focus on how animals generate force in order to move their mouths to eat and their limbs to travel.

### CHAPTER 3: BUILT TO DISCOVER

Find out how eyes co-evolved and the array of senses that animals have that are beyond human's limited five. This section only contains one gallery, but it packs a punch!

## ● EDUCATION TOOLKIT

All components easily accessible via the exhibition site:  
<http://biomechanics.fieldmuseum.org>

### Whyville

Students can explore biomechanics in the new BIOlympics Arena in this massive multiplayer online game environment. They can choose animals to compete in different Olympic style events or explore biomechanics concepts in the "training rooms." <http://www.whyville.net>.



### Videos

Check out the exhibition site for research videos from scientists, the dissection of a giraffe heart, and animations featured in the exhibition.

### Activities

Teachers or parents can supervise students in a number of activities related to domes, surface area-to-volume ratio, muscles, and levers.



### Design Challenges

Challenge your students to design solutions to problems inspired by nature. Our website outlines several NGSS aligned problems to solve and a way to submit your ideas for us to possibly post on our tumblr.

### N.W. Harris Learning Collection

Items in our *N.W. Harris Learning Collection* can be leveraged to highlight key concepts within biomechanics. Check out the exhibition site to see which items align. <http://harris.fieldmuseum.org>



## ● OTHER RESOURCES

### Online Articles Related to Biomechanics

Dinosaur Biomechanics - The Field Museum  
<http://archive.fieldmuseum.org/dinosaurs/allabout.asp>

"Life in Super Slow-motion" – BBC Article, with research videos  
<http://www.bbc.co.uk/news/science-environment-23205563>

Prosthetic Limbs Become More Energy Efficient – Stuff to Blow Your Mind Blog  
<http://www.stufftoblowyourmind.com/blog/prosthetic-limbs-become-more-energy-efficient/>

"Why Don't Woodpeckers Get Headaches?" – Ask a biologist  
<http://askabiologist.asu.edu/plosable/woodpeckers>

### Videos Related to Biomechanics

"This Is Why You Can't Outrun a Cheetah" - Smithsonian  
<http://www.smithsonianchannel.com/sc/web/video/titles/18351/this-is-why-you-cant-outrun-a-cheetah>

"The Fastest Punch in the World" – Smithsonian  
<http://www.smithsonianchannel.com/sc/web/series/1002882/speed-kills/3361623/ocean#the-fastest-punch-in-the-world>

"Linkages – Biomimicry"  
<http://makezine.com/2012/09/24/math-monday-linkages-biomimicry/>  
<http://biomimicrytfm.tumblr.com>

### Careers in Biomechanics

[http://www.asbweb.org/html/biomechanics\\_programs/programs.html](http://www.asbweb.org/html/biomechanics_programs/programs.html)

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