

## Seminars on Science

# SHARKS AND RAYS

## Syllabus

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### Course Title

Sharks and Rays: Ecology, Classification and Evolution

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### Course Description

Sharks may be one of the most readily recognized fishes in the water, but did you know that rays are one of their closest relatives? They share a 450 million-year evolutionary history, evolving extraordinarily successful body plans. This course examines these amazing fishes, their adaptations for survival, how they operate as top predators, how we study them, and why shark conservation is critical.

In this life science seminar, students will draw on the fossil record, museum collections, and research by Museum scientist Dr. Marcelo de Carvalho to become familiar with the basic biology, ecology, diversity, and evolution of sharks and rays (the elasmobranches). Learners will study their complex sensory systems (hearing, smelling, vision, and electrical sensing — perhaps the most advanced of all vertebrates), and find out how sharks and rays use them to navigate and detect prey. Drawing on scientist-authored essays, online interaction, web resources, and videos, the course will also illuminate the tools, techniques and overall process of research in this field, and explain current conservation efforts.

Each week learners examine a specific question and are provided with written and multimedia resources to explore it. The weekly questions are:

- What characters unite sharks and rays as a group?
- What does the fossil record tell us about sharks and rays?
- How many types of sharks and rays are there?
- How do sharks eat?
- How do sharks and rays reproduce?
- Why protect sharks and rays?

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### Class Schedule

This is a six-week online graduate course with an additional week for assignment completion. The course is asynchronous and does not have specific meeting times. Assignments and discussions change on a weekly basis. Students are expected to complete work within the specific week it is assigned.

For the current schedule of offerings, please visit [www.amnh.org/learn/calendar.php](http://www.amnh.org/learn/calendar.php).

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## Instructors

This graduate course is co-taught by an experienced educator along with a research scientist. **For example**, a recent course featured:

**Ms. Marlene Focht**  
Manatee Community College  
Bradenton, FL

**Dr. Marcelo de Carvalho**  
Departamento de Biologia  
Universidade de São Paulo

For current instructor information, please contact [seminfo@amnh.org](mailto:seminfo@amnh.org).

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## Format

1. **Sharks and Rays** is a six-week online graduate course with an additional week for assignment completion. Enrollment is restricted to current or future educators. No prior course in evolutionary science is required.
2. **Weekly activities** involve learners in describing sharks and rays and introduce participants to the technology, tools, and processes scientists use to study their diversity. Computer interactives, image galleries, and videos will help learners visualize and master the content.
3. **Online discussions** encourage reflection on course content, support and model the inquiry process, and sustain interaction between the offering scientists, seminar instructors, and course members.
4. **Final course projects** support either the development of a proposal planning how you might research a question related to a seminar topic you find particularly interesting or the creation of inquiry-based lesson plans focused on a key course concept that you might incorporate into your teaching practice.

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## Required Textbook

This course requires the following textbook.

**Sharks in Question**  
by Victor G. Springer, Joy P. Gold  
Paperback: 192 pages  
Publisher: Smithsonian Institution Press (April 1989)  
ISBN: 0874748771

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## Recommended Textbooks

The following textbooks are recommended as general references but are not required.

**Discovering Fossil Fishes**  
by John G. Maisey  
Hardcover: 223 pages  
Publisher: Henry Holt & Company, Inc. (July 1996)  
ASIN: 0805043667

### **Shark Encounters**

by National Geographic Society  
Video Release Date: April 14, 1997  
ASIN: 6304475853

### **Sharks and the Origins of Vertebrate Immunity**

by Gary W. Litman  
Publisher: Scientific American (November 1996, 67-71)  
Online Archives: Scientific American Digital  
<http://www.sciamdigital.com/>

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## **Support Services**

Technical support is available for technical issues on a 24/7 basis. Please call (303) 873-0005 or email [helpdesk@amnh.college.com](mailto:helpdesk@amnh.college.com).

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## **Grading**

**Assessments** are based on a detailed grading rubric developed for this course:

Course Assignments	30%
Course Participation & Communication	40%
Final Project	30%

1. **Course assignments** will include reflection questions and written assignments.
2. **Class participation** will be evaluated based on the quality and consistency of contribution to the discussion forum. The grades for participation will be posted two weeks after each question opens.
3. **Final Project:** There are two options for the course project:

#### **Option I: Teaching Practice**

This option is for learners who would like an opportunity to develop an application based on the course content that could be taught to students or other educators. The final form may be a unit or workshop plan (if it will be used as part of a professional development experience).

#### **Option II: Research Question**

This option is for learners who would like an opportunity to further explore and grapple with the science and skills presented in this course. The task is to develop a research question of interest based on some element of the content presented in the course.

4. **Policy:** Everything submitted as an assignment, project, or discussion post must be an original work. References to resource materials are expected and proper citation is required.

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## **Weekly Overview and Expectations**

### **Week 1: Introduction to Sharks and Rays**

This week we meet Dr. Marcelo de Carvalho, an ichthyologist and former postdoctoral research fellow at the American Museum of Natural History, who introduces us to some of the remarkable characteristics of sharks and rays. This includes exploring the taxonomic relationships between sharks and rays and the other cartilaginous fishes, as well as the bony fishes.

**Expectations:**

- Become familiar with the biology and ecology of sharks and rays.
- Examine ways that sharks and rays are important species in aquatic ecosystems.
- Study the major taxonomic groups within the Class Chondrichthyes.
- Find out about a number of unique characters that unite the species within the Class Chondrichthyes and at the same time distinguish them from bony fishes.
- Participate in the Icebreaker Discussion
- Respond to the Discussion Question: Elasmobranchs

**Week 2: What does the fossil record tell us about sharks and rays?**

This week learners will be introduced to the science of paleontology and, by examining the known fossil record, will explore some of the diversity and evolutionary history of sharks and rays. Through videos, learners venture into the field with Dr. de Carvalho as he goes fossil hunting in New Jersey. Dr. de Carvalho also shares an inside view into two of his research projects on rays at the American Museum of Natural History.

**Expectations:**

- Examine the 450-million-year evolutionary history of sharks and rays.
- Learn how the fossil record of sharks and rays provides clues that can help explain their diversity today.
- Review the process of fossilization.
- Find out why the earliest fossil remains of cartilaginous fishes are teeth rather than skeletal fragments, and where you might find them.
- Study how scientists use fossil evidence to help explore the evolutionary relationships between modern and extinct groups of species.
- Investigate two of Dr. de Carvalho's fossil ray research projects.
- Examine videos of Dr. de Carvalho demonstrating fossil hunting techniques.
- Learn how to make observations and search for fossils.
- Respond to the Discussion Question: Importance of the Fossil Record
- Complete the Assignment: Fossil Prospecting

**Week 3: How many types of sharks and rays are there?**

The sharks and rays represent one piece of the total biodiversity of our planet. What are some of the many ways these water-dwelling creatures vary? This week, we'll explore the diversity of sharks and rays and take a look at the scientific methods scientists use in their quest to make sense of this diversity.

Dr. de Carvalho walks us through the scientific process of identifying and naming species as he shares some of his own research identifying species of electric rays.

**Expectations:**

- Examine the general morphology of sharks and rays to gain insight into their diversity and variation.
- Discover how taxonomic classifications reflect the evolutionary history of a group.
- Learn that the classification of species changes as research uncovers new information.
- Investigate the genealogical relationships between modern sharks and rays and learn that some sharks are more closely related to rays than they are to other sharks.
- Gain insight into one of Dr. de Carvalho's research projects to identify and distinguish between species of electric rays.
- Investigate the Ichthyology collection of the American Museum of Natural History.
- Learn about the importance of museum collections to scientific research.
- Become familiar with the fundamental questions that are addressed in a systematic study.
- Respond to the Discussion Question: Diversity of Elasmobranchs
- Complete the Assignment: Designing a Fossil Expedition
- Share preliminary thoughts on the content of the Final Project

#### **Week 4: How do sharks eat?**

Teeth...frenzy...voraciousness--all words we associate with sharks in relation to feeding, but just what are the ways sharks and rays detect, locate, capture, and process food? Using videos and the week's reading, learners will study all the elements of the fascinating sensory systems of sharks and rays, including hearing, olfaction, lateral line detection, vision, and electroreception. Dr. de Carvalho will also guide us, on video, through the dissection of a dogfish to expose the internal organs of the digestive tract.

#### **Expectations:**

- Learn about the multiple, complex sensory systems that sharks and rays use to navigate their environment.
- Recognize that sharks and rays have complex sensory mechanisms that allow them to detect and locate prey.
- Investigate the anatomical specializations that enable sharks and rays to capture and ingest prey.
- Hypothesize about the connection between body form and function in sharks and rays.
- View the dissection of a dogfish shark to examine the sensory organs and the internal organs of the digestive tract.
- Respond to the Discussion Question: Comparing Sensory Systems
- Complete the Assignment: Shark/Ray Comparison

#### **Week 5: How do sharks and rays reproduce?**

This week, we are introduced to reproduction among sharks and rays. What special mechanisms have they developed for successful mating? Is it true that certain sharks have "placentae" and umbilical cords? Do sharks bear live young or lay eggs? Learners explore these questions and the biology behind the answers. Dr. de Carvalho also guides us, on video, through dissections to show the reproductive organs of a male and female dogfish. He discusses the form and function of the organs and explains how mating, fertilization, and gestation occur in the dogfish.

#### **Expectations:**

- Learn about the reproductive biology of sharks and rays.
- View the dissection of a dogfish shark to examine the internal organs of the male and female reproduction system.
- Review courtship and mating behaviors of sharks and rays.
- Become familiar with the different types of embryonic and fetal development in sharks and rays.
- Consider the reproductive strategies of sharks and rays, and the relationship of these strategies to ecological change.
- Respond to the Discussion Question: Reproductive Methods
- Submit an outline of the Final Project

#### **Week 6: Why protect sharks and rays?**

Sharks and rays are top predators and, hence, essential components in many marine and some freshwater ecosystems. They also play an important role in regional and global economies, as part of fisheries and eco-tourism. However, species of sharks and rays have come under increasing threat from commercial overfishing, sports fishing, and accidental catch. They are finally beginning to receive the legal attention that is necessary to safeguard them from these threats. This week, learners explore the whys and wherefores of conservation-based legislation as it pertains to sharks. Long overdue protection or extreme measures? Decide for yourself once you are armed with the facts.

#### **Expectations**

- Investigate how the role of sharks as top predators in the oceans affects the marine ecosystem.
- Determine factors that contribute to the vulnerability of shark and ray populations.
- Examine recent conservation-based protective legislation for sharks and rays.
- Draw conclusions about the evolutionary success of sharks and rays.
- Reflect on the relative importance of sharks and rays to the planet's overall biodiversity.
- Respond to the Discussion Question: Evolutionary Success
- Submit the Final Project