AMERICAN MUSEUM & NATURAL HISTORY

Seminars on Science

THE LINK BETWEEN DINOSAURS AND BIRDS

Syllabus

Course Title

The Link Between Dinosaurs and Birds: Evolution and Classification

Course Description

Most people believe that dinosaurs disappeared over sixty million years ago… but in fact, we see living dinosaurs everyday. We call them birds. This course examines the evidence linking dinosaurs to modern birds and investigates how scientists study the evolutionary relationships between species. Learners are introduced to the world's largest collection of vertebrate fossils and the American Museum of Natural History's fourth floor Fossil Halls, exhibiting Saurischian and Ornithischian dinosaurs.

This seminar uses the method of classification called cladistics to define characteristics of a group of dinosaurs called theropods. Using anatomical evidence from fossils and living birds, a case is presented for birds being direct descendents of the theropod lineage. The course looks at the process of fossilization and how scientists look for, collect, and analyze fossils. Bird behavior, along with fossil evidence, is used to infer possible behavior (such as nesting and parental care) of extinct dinosaurs. We also look at the characteristics that make a bird a bird, and explore the bird family tree and the possible origins of flight. The course also examines possible explanations for the extinction of most dinosaurs 65 million years ago.

Scientist authored essays, a virtual exhibition tour, video, and web resources, enable students to explore geologic time, investigate clues to the origin of birds, and theorize about possible causes of extinction.

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**.

Instructors

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

Ms. Jenny Lando
Department of Education
American Museum of Natural History

Dr. Diego Pol
Museo Paleontológico Egidio Feruglio
Argentina

For current instructor information, please contact seminfo@amnh.org.

Format

1. **The Link Between Dinosaurs and Birds** is a six-week online graduate course with an additional week for assignment completion. Enrollment is restricted to current or future educators.

2. **Weekly activities** introduce the processes scientists use to analyze biological details in evolutionary processes and the tools used to locate, examine and prepare fossils. 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.

Required Textbook

This course requires the following textbook.

The Mistaken Extinction: Dinosaur Evolution and the Origin of Birds
By Lowell Dingus, Timothy Rowe
Hardcover: 384 pages; Dimensions (in inches): 0.98 x 11.32 x 8.84
Publisher: W H Freeman & Co.; (October 1997)
ISBN: 071672944X

Recommended Textbooks

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

The Evolution and Extinction of the Dinosaurs
By David E. Fastovsky, David B. Weishampel
Hardcover: 479 pages; Dimensions (in inches): 1.34 x 10.31 x 8.26
Publisher: Cambridge University Press; (April 1996)
ISBN: 0521444969

Discovering Dinosaurs: Evolution, Extinction, and the Lessons of Prehistory
By Eugene S. Gaffney, Lowell Dingus, Mark A. Norell
Paperback: 219 pages; Dimensions (in inches): 0.75 x 10.12 x 8.99
Publisher: University of California Press; (April 8, 2000)
ISBN: 0520225015

Support Services

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

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.

Weekly Overview and Expectations

Week 1: Theropod Anatomy and Genealogy

Dinosaurs have long been a subject of fascination for both children and adults. Part of their mystique is that they went extinct 65 million years ago. But did they? This week Drs. Mark Norell, Sunny Hwang, and Diego Pol introduce evidence that shows one group of dinosaurs did not go extinct. They are related to such well-known dinosaurs as *Tyrannosaurus* and *Velociraptor*, and today we call them birds. First, we look at the classification of this one specific group of dinosaurs, the theropods. Then we look at the general body plan of the extinct members of the theropod group and how their features illuminate their possible behaviors. And finally, with these clues, we begin to illustrate the link between birds and dinosaurs.

Expectations:

- Review the course orientation.
- Find out about the characteristics that define the group known as theropod dinosaurs.
- Understand why not all dinosaurs are extinct.
- Examine the study of cladistics, which uses taxonomic classifications to reflect the evolutionary history of a group.
- Identify the difference between non-avian and avian theropod dinosaurs.
- Evaluate the anatomy and physical characteristics for non-avian theropods.
- Begin to analyze the evolutionary relationships between theropod dinosaurs and modern birds.
- Participate in the Icebreaker Discussion
- Respond to the Discussion Question: Classification
- Respond to the Discussion Question: Theropods

Week 2: Fossilization and Collection of Dinosaurs
Most of what we know about extinct dinosaurs comes from the evidence we find in the fossil record. So learning where to look and spending time in the field looking for fossils is a large part of any paleontologist's work. What is a fossil? Where do you find dinosaur fossils? Once you've found one, how do you retrieve and collect it? What can you learn from fossils? This week we answer these questions and more as we look at the tools and techniques paleontologists use when they are in the field and in the lab. We also go behind-the-scenes in the Museum's vertebrate paleontology preparation laboratory to see how a specimen is prepared.

Expectations:
- Examine the definition of a fossil, how they are formed, and the difference between a life assemblage and a death assemblage.
- Discover why scientists are more likely to find fossils in some places than others.
- Distinguish ways dinosaur fossils are located and collected in the field.
- Discriminate between trace fossils (e.g., footprints) and replacement fossils (where a mineral replaces the bone).
- Look at the tools and techniques preparators use to reveal a fossil by watching a Museum preparator in action.
- Gain insight into the kinds of information paleontologists can gather by analyzing fossils.
- Respond to the Discussion Question: Fossil Collecting

Week 3: Theropod Biology and Behavior
Amazingly, paleontologists know a bit about how non-avian dinosaurs cared for their young, hunted for prey, and even made sounds. How do they know? The fossil record contains some clues—like the amazing specimen of an oviraptorid huddled over a nest of its eggs, similar to how a chicken sits on its nest and the way crocodiles build nests for their young. To study the behavior of long-extinct dinosaurs, paleontologists not only study the fossil record, but also get valuable insight from the behaviors of the living descendents of non-avian dinosaurs, birds, and the closest living relatives of dinosaurs—crocodiles. And finally we examine a controversial topic—were non-avian dinosaurs warm-blooded or cold-blooded?

Expectations:
- Recognize that there are shared behaviors between modern birds and crocodiles.
- Gain insight into the ways paleontologists make inferences about the behavior of long-extinct animals.
- Determine how evidence for the behavior of long-extinct animals can be found in the fossil record.
- Learn how the fossil record of theropod dinosaurs provides clues that help explain the diversity and behavior of modern birds.
- Examine how modern bird and crocodile behavior is similar to the behavior of non-avian dinosaurs.
- Study how scientists use fossil evidence to reconstruct the relationships between extinct species and modern species.
- Look at new evidence that some non-avian theropods were warm-blooded.
- Learn about the excavation and analysis of the dromaeosaur fossil known as "Dave."
- Analyze a chicken or turkey skeleton to find several anatomical features common to both non-avian theropod dinosaurs and modern birds.
- Respond to the Discussion Question: Dinosaur Behavior
- Complete the Assignment: Bird Bone Examination
- Share preliminary thoughts on the content of the Final Project

Week 4: The Origin of Birds
We typically think of feathers, a beak, a wishbone, and a breastbone as the essential characteristics that define a bird. But in the last few decades, scientists have shown that these features aren't unique to birds. How then do we describe birds as a unique group? What is their evolutionary history? We first examine each of the features that have traditionally been identified with birds, and then trace the evolution of birds through their 150-million-year history. During this tour of bird evolution, we highlight the most current knowledge about the features or characters that define birds as a group, and then discuss the link between some of these characters and the non-avian theropod dinosaurs.

Expectations:

- Examine the characteristics traditionally used to describe birds.
- Explore several milestones in the evolution from non-avian theropod to modern bird.
- Determine the evolution of the features that enable birds to fly.
- Grapple with possible reasons for the evolution of feathers, flight, and other bird characters.
- Look at how modern birds fit into the maniraptor family tree.
- Compare several anatomical features of a non-avian dinosaur and an avian dinosaur.
- Hypothesize about the relatedness of an unknown specimen to an advanced non-avian theropod and a modern bird, using key characters.
- Respond to the Discussion Question: What's a Bird?
- Complete the Assignment: Theropods Compared

Week 5: Dinosaur Extinction and Relatedness

Let's now return to the mystery that surrounds the extinction 65 million years ago of what we now know was most, but not all, of the dinosaurs. The cause of the event is still shrouded in mystery. This week we look at some of the proposed theories to explain this massive extinction. In particular, we examine the evidence for the two leading theories—a meteorite impact and extensive volcanism. We look at the evidence that supports and refutes these explanations, and begin to hypothesize about how the group of theropod dinosaurs we call birds and other small animals survived this mass extinction.

Expectations:

- Explore the pattern of the disappearance of non-avian dinosaurs 65 million years ago.
- Review different theories for the Cretaceous/Tertiary (K/T) extinction.
- Examine and evaluate the evidence for the two leading extinction theories—meteorite impact and volcanism.
- Respond to the Discussion Question: Extinction
- Submit an outline of the Final Project

Week 6: Living Dinosaurs and Their History After the Demise of Traditional Dinosaurs

This week we come full circle and review the evidence that links modern birds to non-avian theropod dinosaurs. We look at the tremendous diversity of dinosaurs and birds found in the fossil record. Where did the dinosaur lineage split, and when do we find the first characters for Aves? We know that a split occurred, but these days the divergence still raises more questions than answers. Maybe birds aren't as special as we thought.

Expectations:

- Examine the tremendous 230-million-year evolutionary history of all dinosaurs (the group Dinosauria).
- Review how scientists make educated guesses about events in evolutionary history.
- Analyze the evidence scientists have so far to identify the point in the family tree at which non-avian theropod dinosaurs split from avian theropod dinosaurs.
- Investigate how the minimum divergence age (MDA) is used to identify the latest possible date at which groups split from one another in their family tree.
- Revisit the characteristics traditionally used to describe birds, and whether those characteristics can still be used to classify birds as a group.
- Respond to the Discussion Question: The Science of Paleontology
- Submit the Final Project