



1. **DESCRIPTION:** Teams identify and classify fossils and demonstrate their knowledge of ancient life. Tasks **will be** related to interpretation of past environments and ecosystems, adaptations, evolutionary relationships, and **the** use of fossils in dating and correlating rock units.

**A TEAM OF UP TO: 2**

**APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- a. Each team may bring one (1) magnifying glass and one (1) **three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted.**
- b. Each team may also have one commercially produced field guide which may be tabbed and annotated.
- c. **In addition to the resource binder and field guide, each team may bring one (1) copy of the 2024 Science Olympiad Fossil List, which does not have to be secured in the binder and two stand-alone non-programmable, non- graphing calculators (Class II).**
- d. **Teams are not permitted to bring samples or specimens to the event.**
- e. If the event features a rotation through a series of laboratory stations where the participants interact with
- f. samples, specimens, or displays; no material may be removed from the binder, **except for the 2024 Science Olympiad Fossil List.**

3. **THE COMPETITION:**

- a. Where possible, participants will move from station to station, with the length of time at each station predetermined and announced by the Event Supervisor.
- b. Participants may not return to stations but may continue to work on their responses throughout.
- c. Stations will feature task-oriented activities emphasizing application of paleontological concepts.
- d. Identification will be limited to specimens on the **2024 Science Olympiad Fossil List**, but other samples may be used to illustrate key concepts.
- e. Questions will be chosen from the following topics:
  - i. Identification of fossil specimens on the **2024 Science Olympiad Fossil List**
  - ii. Taxonomic classification restricted to the hierarchy on the Science Olympiad Fossil List
  - iii. Conditions **that favor preservation of fossils (e.g., rapid burial, hard parts, low oxygen environment, escape destruction)**
  - iv. Common modes of preservation: petrification/petrifaction (e.g., permineralization & mineral replacement including silicification, pyritization, **and phosphatization**), cast, external vs. internal molds (steinkerns), imprints, carbonization, unaltered remains (e.g., **shells, teeth**)
  - v. Uncommon modes of preservation: **limited to** encasement in amber, mummification, freezing, tar
  - vi. **Bias in the Fossil Record: e.g., animals with mineralized hard parts (skeletons or shells) more likely preserved than soft bodied animals; aquatic organisms more likely to be preserved than terrestrial (land) organisms**
  - vii. **Determining the age of fossils and the rocks they are in through relative or absolute dating techniques.**
    - (1) **Relative dating techniques: limited to** law of superposition, original horizontality, cross-cutting relationships, unconformities, **faunal succession, correlation of rock layers and/or fossils**
    - (2) **Absolute dating techniques: limited to** radiometric dating, including half-life, radioactive isotopes used (e.g., **Carbon 14, Potassium/Argon, Uranium/Lead**)
    - (3) **Limitations of relative and absolute dating in determining the age of fossils**
    - (4) **Use of radiometric dating of igneous rocks and volcanic ash along with relative dating techniques to determine the age of fossils.**
  - viii. The Geologic Time Scale, its organization, major events, the 5 major mass extinctions, and the Pleistocene-Holocene extinction of megafauna. An official Science Olympiad Geologic Time Scale is posted at [soinc.org](http://soinc.org) & should be used for all competitions
  - ix. Index Fossils: characteristics and use in determining the age of rocks & geologic formations
  - x. Fossil-bearing sedimentary rocks **and their significance in interpreting ancient environments and habitats**
  - xi. Modes of life **and mobility: benthonic/benthic (infaunal vs epifaunal; sessile vs vagrant); planktonic/planktic; nektonic/nekctic (swimmers); terrestrial**



- xii. **Ecologic role and trophic level (role in food web): producers, filter/suspension feeder, predator, scavenger, deposit feeder (detritovore), herbivore**
- xiii. **Differences in plant reproduction through seeds or spores.**
- xiv. **Environments: marine (e.g., shallow marine/shelf, reef, lagoon, deep marine); terrestrial (e.g., tropical, temperate forest, grassland, wetlands, desert, taiga, tundra), fresh water (e.g., lakes, rivers, swamps)**
- xv. **Mineral and organic components of exoskeletons, shells, and bones/teeth (e.g., calcite, aragonite, silica, chitin, biological apatite/calcium phosphate)**
- xvi. **Adaptations and morphologic features and their implications (e.g., serrated sharp teeth in vertebrates indicate predatory behavior)**
- xvii. **Significance of important paleontological discoveries (e.g., non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx*)**
- xviii. **Paleontological significance of *Lagerstätten* (conservation and concentration) limited to: Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and La Brea Tar Pits**
- xix. **Major evolutionary events, trends, and transitions: (e.g., Cambrian Explosion, Ordovician Radiation, Mesozoic Marine Revolution, Mesozoic-Cenozoic Radiation; suture patterns in cephalopods, fish to tetrapods transition, evolution of birds from dinosaurs, evolution of whales, evolution of horses)**
- xx. **Convergent evolution: (e.g., fins in fish, marine reptiles, and mammals; wings in insects, pterosaurs, birds, and bats)**
- xxi. **Interpretation of cladograms to show evolutionary relationships**
- xxii. **Stromatolites, how they form, their role in the history of life and the development of Earth's atmosphere, including the Great Oxygenation Event**
- xxiii. **Trace fossils (ichnofossils) as evidence of fossil behavior. Limited to trails, tracks & trackways, footprints, resting traces, borings, burrows, tubes, predation marks, and coprolites**
  - (1) Use of dinosaur footprints to calculate hip height of animal
  - (2) Use of dinosaur trackway to determine running or walking speed

#### 4. **SAMPLE QUESTIONS/TASKS:**

- a. Identify each fossil, and record its mode of preservation.
- b. List samples in order from oldest to most recent.
- c. Based on the fossil and **the type of rock it is**, determine the environment in which the organism lived. (e.g., **Seed fern in black shale indicates terrestrial swamp**)
- d. The fossils illustrated (**ichthyosaur, pterosaur, and *Archeopteryx***) were discovered in the Solnhofen Limestone, a unique Lagerstätten in Germany. What geological period is indicated based on the specimens in this limestone?
- e. Describe the evolutionary relationships between the organisms illustrated on the family tree (cladogram/phylogenetic tree).
- f. **A volcanic ash layer is discovered within a continuous sequence of fossiliferous limestones. Through the use of radiometric isotopes, the ash layer is determined to be 370 million years old. What is the most likely time period of the fossils in the limestone?**
- g. Construct a range chart and determine the age of the fossil assemblage **by using the data provided for each fossil. Based on the range of the fossils present, what is the age of the assemblage? Which specimen would be the best Index Fossil?**
- h. **The image and diagram show a dinosaur footprint. Using the measurements provided, determine the hip height of the dinosaur.**

#### 5. **SCORING:**

- a. High score wins.
- b. Points will be awarded for the quality and accuracy of answers, the quality of supporting reasoning, and the use of proper scientific methods of responses.
- c. Ties will be broken by the accuracy and quality of answers to pre-selected questions and/or sections.

**Recommended Resources:** The Science Olympiad Store ([store.soinc.org](http://store.soinc.org)) carries a variety of resources to purchase for this event; other resources are on the Event Pages at [soinc.org](http://soinc.org)



## KINGDOM PROTOZOA

### Phylum Foraminifera (Forams) \*

Order Fusulinida (Fusulinids)\*

Genus *Triticites*\*

Order Rotaliida\*

Genus *Nummulites*\*

## KINGDOM ANIMALIA

### SPONGES (Phylum Porifera)\*

Genus *Astraeospongia* (calcareous sponge)\*

Genus *Hydnoceras* (glass sponge)\*

### BRYOZOANS (Phylum Bryozoa)

Growth forms: branching, massive, fenestrate)

Genus *Archimedes*

Genus *Rhombopora*

### GRAPTOLITES (Phylum Hemichordata)\*

Order Dendroidea (benthic graptolites)

Order Graptoloidea (planktic graptolites)

### CORALS (Phylum Cnidaria)

Order Tabulata (tabulate corals)

Genus *Favosites*

Genus *Halysites*\*

Order Rugosa (rugose corals)

Genus *Heliophyllum* (horn coral)

Genus *Hexagonaria*

Order Scleractinia (stony corals)

Genus *Septastrea*

### ARTHROPODS (Phylum Arthropoda)

Subphylum Crustacea (shrimp, lobsters, crabs, barnacles, ostracods)\*

Subphylum Chelicerata

Order Eurypterida (Eurypterids)

Genus *Eurypterus*

Class Insecta (Insects)

Class Trilobita (Trilobites)

### Polymerids

Genus *Cryptolithus*

Genus *Calymene*

Genus *Elrathia*

Genus *Isotelus*\*

Genus *Eldredgeops* (formerly *Phacops*)

### Agnostids

Genus *Peronopsis*

## BRACHIOPODS (Phylum Brachiopoda)

Class Inarticulata

Genus *Lingula*

Class Articulata

Genus *Atrypa*

Genus *Composita*

Genus *Juresania*\*

Genus *Leptaena*\*

Genus *Mucrospirifer*

Genus *Platystrophia*

Genus *Rafinesquina*

## MOLLUSKS (Phylum Mollusca)

Class Bivalvia (clams, oysters, mussels)

Genus *Exogyra*

Genus *Gryphaea*

Genus *Pecten*

Genus *Glycymeris*

Genus *Astarte*

Genus *Nucula*

Class Cephalopoda

Order Goniatitida (goniatites)\*

Order Ceratitida (ceratites)\*

Order Ammonitida (ammonites)

Genus *Baculites*

Genus *Dactylioceras*

Order Belemnitida (Belemnites)

Genus *Belemnitella*

Order Nautilida (Chambered Nautilus)

Order Orthocerida ("Orthoceras")

Class Gastropoda (Snails) Genus *Conus*

Genus *Cypraea*

Genus *Platyceras*

Genus *Turritella*

Genus *Worthenia*

## ECHINODERMS (Phylum Echinodermata)

Class Asteroidea (Starfish)\*

Class Blastoidea

Genus *Pentremites*

Class Crinoidea (stems, columns, calyxes)

Class Echinoidea

(regular or irregular echinoids: sea urchins, sand dollars and heart urchins)

Class Ophiuroidea (brittle stars)\*



## VERTEBRATES (Phylum Chordata)

Superclass Agnatha (Jawless Fish) (Ostracoderms)\*

Class Placodermi (Armored Jawed Fish)

Genus *Bothriolepis*

Genus *Dunkleosteus*

Class Chondrichthyes (Cartilaginous Fish)

Superorder Selachimorpha (Sharks)

Genus *Otodus*

Genus *Carcharocles* (formerly *Carcharodon*)

Species *C. megalodon*

Superorder Batoidea (Rays)\*

Superclass Osteichthyes (Bony Fish)

Class Actinopterygii (ray-finned)

Genus *Knightia*

Genus *Xiphactinus*\*

Class Sarcopterygii (lobe-finned)

Genus *Eusthenopteron*

Genus *Latimeria* (Coelacanth)

Genus *Tiktaalik*

Class Amphibia (Amphibians)

Genus *Acanthostega*

Genus *Eryops*

Genus *Diplocaulus*

Class Reptilia (Reptiles)

Order Crocodilia (crocodiles)\*

Order Testudines (turtles)\*

Order Ichthyosauria (Ichthyosaurs)

Order Squamata

Family Mosasauridae (Mosasaurs)

Order Plesiosauria (Plesiosaurs & Pliosaurs)

Order Pterosauria (Pterosaurs)

Clade Dinosauria (Dinosaurs)

Order Saurischia (lizard-hipped)

Suborder Theropoda

Genus *Allosaurus*

Genus *Coelophysis*

Genus *Dilophosaurus*

**Genus *Deinonychus*\***

Genus *Spinosaurus*\*

Genus *Tyrannosaurus*

Genus *Velociraptor*

Suborder Sauropodomorpha

**Genus *Apatosaurus*\***

Genus *Brachiosaurus*

Genus *Diplodocus*

Genus *Patagotitan*\*

Genus *Plateosaurus*

Order Ornithischia (bird-hipped)

Infraorder Ankylosauria

Genus *Ankylosaurus*

Infraorder Ceratopsia

Genus *Triceratops*

Genus *Protoceratops*\*

Infraorder Ornithopoda

Genus *Iguanodon*

Genus *Parasaurolophus*

Genus *Maiasaura*

Infraorder Pachycephalosauria

Genus ***Pachycephalosaurus*\***

Infraorder Stegosauria

Genus *Stegosaurus*

Class Aves (Birds)

Genus *Archaeopteryx*

Genus *Titanis* (Terror Bird)

**Genus *Hesperornis*\***

Clade Synapsida

**Stem Mammals/Proto-Mammals**

Genus *Dimetrodon* (pelycosaurs)

Genus *Lystrosaurus* (therapsids)

**Genus *Gorgonops* (therapsid)\***

Class Mammalia (Mammals)

Genus *Basilosaurus* (prehistoric whale)

Genus *Equus* (modern horse)

Genus *Mesohippus* (three-toed horse)

Genus *Australopithecus* (hominin)\*

Genus *Homo* (hominin)

Species *H. neanderthalensis*

Species *H. erectus*\*

Species *H. sapiens*

Genus *Mammut* (Mastodon)

Genus *Mammuthus* (Mammoth)

Species *M. primigenius*

Genus *Megacerops* (brontothere)

**Genus *Megalonyx* (Giant Ground Sloth)\***

Genus *Smilodon* (saber-toothed cat)

**Genus *Merycoidodon* (oreodont)\***



## **KINGDOM PLANTAE**

### **FLOWERING PLANTS (Division Anthophyta)**

Genus *Acer* (Maple)

Genus *Populus* (Aspen & Poplar)

Genus *Platanus* (Sycamore)

### **GINKGOS (Division Ginkgophyta)**

Genus *Ginkgo*

### **CLUB MOSSES (Division Lycophyta)**

Genus *Lepidodendron* (scale tree)

### **CONIFERS (Division Pinophyta)**

Genus *Metasequoia*

### **HORSETAILS (Division Sphenophyta)**

Genus *Calamites* (form leaf genus: *Annularia*)

### **SEED FERNS (Division Pteridospermatophyta)**

Genus *Glossopteris*

### **TRUE FERNS (Division Polypodiophyta)**

Genus *Psaronius* (form leaf genus: *Pecopteris*)

## **ADDITIONAL EARTH MATERIALS**

Trace Fossils **limited to:**

Trails, Tracks, Trackways, Borings, Burrows,

Tubes, Predation marks, Coprolites

Stromatolites

Amber/copal

Petrified wood

Sedimentary Rocks **limited to:**

Coquina

**Chalk**

**Fossil limestone**

Sandstone

Shale

Chert