FOSSILS

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams identify and classify fossils and demonstrate their knowledge of ancient life by completing tasks related to interpretation of past environments and ecosystems, adaptations and evolutionary relationships, and 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 magnifying glass, the *Science Olympiad Official Fossil List* and **one 2" or smaller** three-ring binder, as measured by the interior diameter of the rings, containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted.
   b. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays; no material may be removed from the binder.

3. **THE COMPETITION:**
   a. 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 *Science Olympiad Official Fossil List*, but other samples may be used to illustrate key concepts.
   e. Questions will be chosen from the following topics:
      i. Identification of all fossil specimens on the *Science Olympiad Official Fossil List*
      ii. Taxonomic classification restricted to the hierarchy on the *Science Olympiad Official Fossil List*
      iii. Conditions required for a plant or an animal to become fossilized
      iv. Common modes of preservation: petrification/petrifaction (e.g., permineralization & mineral replacement including silicification and pyritization), cast, **external vs. internal molds (steinkerns),** imprints, carbonization, unaltered remains
      v. Uncommon modes of preservation: encasement in amber, mummification, freezing, tar
      vi. Relative dating: law of superposition, original horizontality, cross-cutting relationships, unconformities
      vii. Absolute dating: radiometric dating (i.e., **Carbon 14 dating)**, including half-life, **radioactive isotopes used**, and **use of igneous rocks and** volcanic ash layers **in absolute dating**
      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 & 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: limestone, shale, sandstone, coquina, **chert**
      xi. Modes of life: filter feeder, predator, scavenger, deposit feeder, benthic, pelagic
      xii. Environments: shallow marine, **reef, lagoon**, deep marine, terrestrial, fresh water
      xiii. Mineral and organic components of exoskeletons, shells, and bones/teeth (e.g., calcite, aragonite, silica, chitin, biological apatite)
      xiv. Adaptations and morphologic features of major fossil groups
      xv. Important paleontological discoveries (i.e., non-avian dinosaurs with feathers; transitional species such as *Tiktaalik* and *Archaeopteryx*)
      xvi. *Lagerstätten* (conservation and concentration) and their significance, 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
      xvii. Fossils as evidence for evolutionary trends and patterns such as morphological adaptations within groups, major evolutionary events **and transitions** (e.g., Cambrian Explosion, **Mesozoic Marine Revolution**, fish to tetrapods, dinosaurs to birds, whales, horses)
      xviii. **Trace fossils (ichnofossils) including, but not limited to trails, trackways, borings, burrows, tubes, predation marks, repair scars, and coprolites**
      xix. **Stromatolites, how they form, and their role in the history of life and development of Earth's atmosphere**

4. **SAMPLE QUESTIONS/TASKS:**
   a. Identify each fossil, record its mode of preservation, the type of rock the sample is embedded in, and the geologic period it represents.
   b. List samples in order from oldest to most recent.
   c. Based on the fossil and rock associations, determine the environment in which the organism lived.
   d. **The fossils illustrated were discovered in the Solnhofen Limestone, a unique Lagerstätten in Germany. What geological period is indicated based on the specimens in this limestone?**
   e. **How can the occurrence of both marine and terrestrial animals in the Solnhofen Limestone be explained?**
   f. **Describe the evolutionary relationships between the organisms illustrated on the family tree (cladogram/phylogenetic tree).**
   g. Construct a range chart and determine the age of the fossil assemblage.
5. **SCORING:**
   a. High score wins. Points will be awarded for the quality and accuracy of responses.
   b. Ties will be broken by the accuracy and/or quality of responses to several pre-identified questions.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Fossils CD, the Bio/Earth Science CD, and the *Smithsonian Handooks: Fossils*; other resources are on the event page at soinc.org.

FOSSIL LIST

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KINGDOM PROTOZOA

Phylum Foraminifera (Forams) *
- Order Fusulinida (Fusulinids)*
- **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 Scleratinia (stony corals)**
  - Genus *Septastrea*

ARTHROPODS (Phylum Arthropoda)
- Subphylum Crustacea (shrimp, lobster, crabs, barnacles, ostracods)*
- **Subphylum Chelicerata**
  - Order Eurypterida (Eurypterids)
- Class Insecta (Insects)
- Class Trilobita (Trilobites)
  - Genus *Cryptolithus*
  - Genus *Calymene*
  - Genus *Elrathia*
  - Genus *Isotelus**
  - Genus *Eldredgeops* (formerly *Phacops*)

BRACHIOPODS (Phylum Brachiopoda)
- Class Inarticulata
  - Genus *Lingula*
- Class Articulata
  - Genus *Atrypa*
  - Genus *Composita*
  - Genus *Juresania**
  - Genus *Leptaena*
  - Genus *Mucrospirifer*
  - Genus *Platystrophia*
  - Genus *Rafinesquina*
  - Order Rhynchonellida

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 including 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*

Note: Taxa marked by an asterisk (*) are for State and National Tournaments only

FOSSIL LIST (CONT.)

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 *Spinosaurus****
    - Genus *Tyrannosaurus*
    - Genus *Velociraptor*
  - **Suborder Sauropodomorpha**
    - **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 *Dracorex*
  - **Infraorder Stegosauria**
    - Genus *Stegosaurus*

Class Aves (Birds)
- Genus *Archaeopteryx*
- Genus *Titanis* (Terror Bird)
- **Genus *Ichthyornis****

Clade Synapsida
- Mammal-like Reptiles
  - Genus *Dimetrodon* (pelycosaurs)
  - Genus *Lystrosaurus* (therapsids)

Class Mammalia (Mammals)
- Genus *Basilosaurus* (prehistoric whale)
- Genus *Equus* (modern horse)
- **Genus *Australopithecus* (hominin)***
- Genus *Homo* **(hominin)**
  - Species *H. neanderthalensis*
  - **Species *H. erectus****
  - **Species *H. sapien***
- Genus *Mammut* (Mastodon)
- Genus *Mammuthus* (Mammoth)
  - **Species *M. primigenius***
  - **(Wooly Mammoth)**
- Genus *Megacerops* **(**Brontothere)
- Genus *Mesohippus* (three-toed horse)
- Genus *Smilodon* (saber-toothed cat)

KINGDOM PLANTAE

FLOWERING PLANTS (Phylum Anthophyta)
- Genus *Acer* (Maple)
- Genus *Populus* (Aspen & Poplar)
- Genus *Platanus* (Sycamore)

GINKGOS (Phylum Ginkgophyta)
- Genus *Ginkgo*

CLUB MOSSES (Phylum Lycopodiophyta)
- Genus *Lepidodendron* (scale tree)

CONIFERS (Phylum Pinophyta)
- Genus *Metasequoia*

HORSETAILS (Phylum Sphenophyta)
- Genus *Calamites* **(form leaf genus**: *Annularia)*

SEED FERNS (Phylum Pteridospermatophyta
- Genus *Glossopteris*

TRUE FERNS (Phylum Pteridophyta)
- **Genus *Psaronius* (form leaf genus:** *Pecopteris)*

ADDITIONAL EARTH MATERIALS

Trace Fossils
- Trails, Tracks, Trackways,
- Borings, Burrows, Tubes
- Predation marks, Repair scars
- Coprolites

Stromatolites
Amber/copal
Petrified wood
Sedimentary Rocks
- Coquina
- Limestone (Chalk/Fossil limestone)
- Sandstone
- Shale
- **Chert**

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