

Building a Time Line: a Brief Biological and Geological History of Earth

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Abstract

Life has existed on Earth for more than 4 billion years. Earth currently is the only planet known to contain life. A large diversity of life forms exists, which is a result of evolutionary process. Which life forms appeared first and when did they appear? What geological conditions set the stage for the appearance of these many diverse life forms? This activity approaches this subject by constructing biological and geological events on a time line.

Activity

Invitation for User Feedback. If you have used the activity and would like to provide feedback, please send an e-mail to MicrobeLibrary@asmusa.org. Feedback can include ideas which complement the activity and new approaches for implementing the activity. Your comments will be added to the activity under a separate section labeled "Feedback." Comments may be edited.

INTRODUCTION

Preparation Time.

One must label the 3 by 5 inch cards and place a clothesline in the classroom, this should not take more than 15 minutes. The cards can be reused so prep time is minimal in the future.

Class Time.

Initial placement of time markers can be limited to several minutes. Discussion can vary, depending on number of approaches one wants to discuss (see below).

Learning Objectives.

By completing this activity students will form a model of the evolution of life on this planet based on the available evidence. Additional remodeling of their view may occur as a result of class discussion of events.

PROCEUDRE

Materials.

- A piece of rope (a 50 foot clothesline works well)
- clothespins
- 3 by 5 inch cards with events written on them (see [Suggested list](#))
- [Student Reflection handout](#)

Student Version.

You will receive a clothespin with an attached 3 by 5 inch card which has some biological event written on it. Place the event in its appropriate place on the timeline that is marked for chronological time and particular geological events with 3 by 5 inch cards of a different color. Write your rationale for choosing that place for the card and answer questions about what came prior to and after your particular event on the Student Reflection Handout.

Instructor Version.

The instructor hands out cards and clothespins and asks students to answer the questions on the Student Reflection handout first and then place the card on the time line. After all students are finished, the instructor points to a particular card, reads the event, and facilitates class discussion about its placement. The instructor can announce some of the other events to ask if students feel the card is in the proper location compared to the others. After the discussion, the class votes whether the selected card is in a reasonable place or not. At this point the card can be moved to another location if necessary. The instructor moves on to another card and continues the process until all cards have been discussed.

It is sometimes necessary to start a discussion of evolution by stating the definitions of a **scientific theory** (something that is the most parsimonious explanation for the available facts and may connect various hypotheses as well as be useful in a predictive sense), a **hypothesis** (a suggested explanation for a group of facts), and a **belief** (an opinion that is held by an individual or group of individuals without positive proof). The scientific theory of evolution is not a speculative idea or belief that can be dismissed as merely someone's opinion but rather it is backed by substantial evidence, and there are no other satisfactory explanations for the history of life on this planet.

Safety Issues. None.

ASSESSMENT and OUTCOMES

Suggestions for Assessment.

Each student fills out a sheet about the placement of his/her event and hands it in to instructor.

Dissonance of one's core beliefs and facts can be a frustrating experience for an individual. There is the possibility that some individuals will not want to participate because of their beliefs. It is hoped that by encouraging discussion based on the definitions mentioned in the background, students will come to an understanding that the theory of evolution is firmly grounded with large amounts of data from various disciplines. A writing assignment where students express their beliefs on evolution before and after the class discussion may be appropriate.

A possible extension would be for the students to go out and find some primary research articles on their particular topic. They could write a brief paper about the significance of the researchers' findings.

Field Testing.

This activity has been used several times, once in a microbiology class during one lecture period (55 minutes). It has been used with three groups of in-service teachers at workshops and one group of preservice teachers in a science methods class. It is a very effective icebreaker; everyone has some opinion on evolution. Moderate the session, stand back, enjoy.

Student Data.

There is a compression of the biological world, in most people's view. Most classes place the origin of bacteria much later in geological time than the evidence supports. The "eukaryotic world" is usually placed much further back in geological time, and every event since then is moved back in time as well. Some place dinosaurs in the right time frame, but still have a hard time with all other "modern" events involving the macroscopic world.

SUPPLEMENTARY MATERIALS

Possible Modifications.

One could begin with cards on the time line, but not in the correct order, and then assign individuals the job of moving the cards to the correct positions. Another option is to first perform this activity with the geological events and then place the biological events on the same time line.

Internet Sources and References.

- Creation Science and Earth History - <http://www.geocities.com/earthhistory/>
- The Evolution Education Site Ring - <http://www.gate.net/~rwms/EvoEvidence.html>
- The Fossil Record: Evolution or "Scientific Creation" - http://www.gcssepm.org/special/cuffey_00.htm
- National Center for Science Education, Defending the Teaching of Evolution in Public Schools - <http://ncseweb.org/>
- Palaeontology Research Group, University of Bristol - <http://palaeo.gly.bris.ac.uk/>
- The Talk.Origins Archive - <http://www.talkorigins.org/>

Curriculum Resources

List of Suggested Events

Please choose whether you want to write the event and date on the geological cards and place them on the line prior to students beginning the activity (faster) or place all events on cards and allow students to determine time and placement of all cards. Write only the event on the biological cards, the students are trying to determine the time and placement of these cards. Feel free to add or subtract other significant events. Also consider making your suggestions known to MicrobeLibrary so that the activity itself can be modified for all to enjoy.

Geological Events

Time (in millions of years)	Event
4,600	Creation of earth and our solar system
4,000	End of major impacts by other particles
3,800	Solidification of earth's crust, formation of first rocks
3,500	Condensation of water from atmosphere and formation of oceans
2,400	Increase of oxygen leads to beginning of banded iron formations
2,000	Transition to stable aerobic hydrosphere and atmosphere
515	Formation of Burgess Shale fossilization
375	Formation of Appalachian mountains
200	Pangaea begins to break apart
65	Cretaceous-Tertiary boundary
0.025	Most recent ice age

Biological Events

Time (in millions of years)	Event
3,800	First unicellular organisms
3,500	First photosynthetic organisms begin releasing oxygen, cyanobacteria present
1,200	First eukaryotic organisms
1,000	Beginning of multicellular eukaryotes
650	Mass extinction of most stromatolites and many soft-bodied organisms
545	Cambrian explosion of hard-bodied organisms
500	First vertebrates—fish
430	First land plant
420	First land animals-millipedes
375	First sharks
350	Expansion of amphibians
350	First insects
350	First plants with roots-ferns
300	Expansion of reptiles

300	Development of winged insects
250	Permian mass extinction
225	Bees, roaches, and termites have evolved
200	First crocodiles
200	First mammals
145	Archaeopteryx
75	Rise of mammals
65	Mass extinction of dinosaurs
50	First monkeys
20	First apes, chimpanzees, and hominids
6	Split of ape and hominid lines
4	<i>Australopithecus</i> , beginning of bipedalism
2	Widespread use of stone tools
1	Widespread use of fire
0.2	First <i>Homo sapiens</i>
0.02	Cave paintings in Altamira Cave
0.01	First human permanent settlements
0.006	Writing developed in Sumeria

 Curriculum Resources

Student Handout.

Name _____

Please answer the top part of this sheet (questions 1 to 6) prior to the overall class discussion. Questions 7 to 9 should be answered at the end of the class period.

Questions 10 to 14 are designed for you to take home and to gather additional information about them prior to answering. Please be sure to include sources of information.

(To be answered prior to class discussion)

1. Event.
2. Date you believe this began on earth.
3. Evidence for your position.
4. Other information that you would like to collect to strengthen your position.
5. What events led to your event?
6. Additional actions that could occur as a result of your event.

(To be answered prior to leaving class)

7. Rationale for positioning of your event after class discussion.

8. Did it move after class discussion?

9. If so, why? If not, why not?

(To be answered after further research)

10. Revised date that you found for your particular event after further investigation by you.

11. Evidence you found to support this position.

12. Other information that is still lacking that would be important to strengthen its placement.

13. What events led directly or indirectly to your event?

14. What additional actions occurred directly or indirectly as a result of your event?