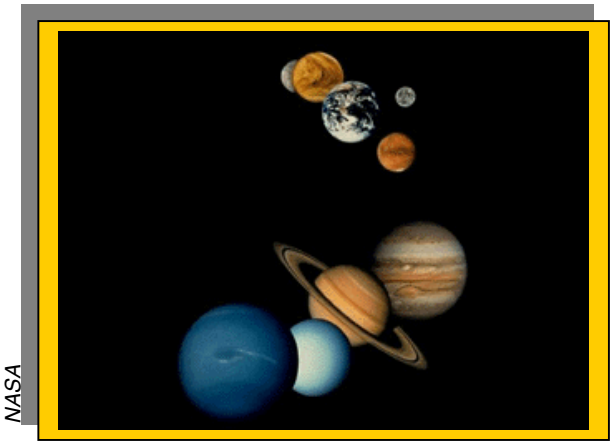
Science Modules

This science module focuses on the planets of our Solar System. If you are using Genesis science modules for the first time, read the User's Guide thoroughly before you begin. (*View User's Guide as PDF.*)

The following classroom materials are available in Portable Document Format (PDF) for your browsing and printing convenience. The files are print-optimized, and should be printed to achieve maximum resolution. **Adobe's new Acrobat Reader 4.0 is required** to view and/or print. To install the FREE reader, visit the Adobe Web site.

Take a look at additional science modules that are available on the Genesis Web site. All technical terms in the science modules are compiled in the Glossary for easy access.

Technology Applications are available for this module.



NASA

Cosmic Chemistry: Planetary Diversity

The goal of this module is to acquaint students with the planets of the solar system and some current models for their origin and evolution. In the *Cosmic Chemistry: The Sun and Solar Wind* module, we focused on an almost universally-accepted standard model, which was developed as information was collected over time. Unfortunately, in the present case, no single planetary formation model satisfactorily explains everything that has been observed. The information that is currently being collected by terrestrial instrumentation and data currently being detected by spacecraft such as Genesis will result in new models and interpretations as well.

During the explorations of the *Cosmic Chemistry: Planetary Diversity* module, students will make decisions concerning possible patterns or groupings of the physical and chemical compositions of internal structures and atmospheres of planets. Through classroom activities, they will be encouraged to examine some contemporary models proposed to explain the origin and evolution of the planets. In the final assessment activity students will use these experiences to predict the properties of the "the missing planet" that could have formed in the asteroid belt.

Instructional materials for this phase are incorporated into Exploration activities below.

Briefing

The primary objective of the Genesis mission is to collect samples of solar wind particles and return them to Earth for detailed analysis. Precise analysis of these particles, which will provide solar isotopic and elemental abundances, will form a basis for testing models of solar system formation and evolution and early nebular composition.

It is presumed that the nine planets, among other highly diverse objects of our solar system, originated from a relatively homogeneous solar nebula. However, evolutionary processes resulted in rocky planets with varying strengths of magnetospheres, giant gaseous planets, satellites, comets, and asteroids. The atmospheres surrounding these bodies are as varied as the bodies themselves. Many models have been developed to explain not only the origins, but also the changes necessary to produce such diversity. None of these models fits all the known planetary data.

It is assumed that the sun has changed the least. Therefore, Genesis is designed to determine solar particle abundances at the precision required to explain scientific data from other space missions and to test fundamental assumptions, such as whether or not solar and nebular compositions are identical.

Curriculum Connections
National Standards Addressed

Grades 5-8

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Properties and changes of properties in matter
- Transfer of Energy

Earth and Space Science
- Structure of the Earth System
- Earth's history
- Earth in the Solar System

Science and Technology
- Abilities of Technological Design
- Understandings about Science and Technology

History and Nature of Science
- Science as a Human Endeavor
- Nature of Science
- History of Science

Infrared Spectroscopy "Here Comes the Heat"
- Teacher Guide
- Student Text
- Student Activity
- Student Data Sheet
- Student Handout

Are We Related? Looking for Patterns in Planetary Diversity
- Teacher Guide
- Student Activity
- Student Handout

"So, Mr. Holmes, What is the Problem?"
- Student Text

Solar Nebula Supermarket
- Student Text

PowerPoint Presentation

PowerPoint Presentation as PDF
- Teacher Guide for PowerPoint
- Teacher Notes for Power Point

Exploration

Just as scientists like Mendeleev found order and patterns in a seemingly chaotic set of information (see Genesis module, *Cosmic Chemistry: An Elemental Question*), astronomers, astrophysicists, and astrochemists are trying to "order" overwhelming amounts of cosmic data from multiple sources.

The teacher's primary instructional role is socratic in the activities of this *Cosmic Chemistry: Planetary Diversity* module. Through effective verbal and written questioning, students will explore the role of infrared radiation in determining planetary characteristics in "Here Comes the Heat." This activity not only serves as an introduction to the study of planetary diversity, but can also serve as a link between this Genesis module and the previous one entitled, *Cosmic Chemistry: The Sun and Solar Wind*.

Curriculum Connections
National Standards Addressed

Grades 9-12

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Structure of atoms
- Structure and properties of matter

Earth and Space Science
- Energy in the Earth System
- The Origin and Evolution of the Earth System
- The Origin and Evolution of the Universe

Science and Technology
- Abilities of Technological Design
- Understandings about Science and Technology

History and Nature of Science
- Science as a Human Endeavor
- Nature of Scientific Knowledge

Student Mission

Students will explore the conformities and anomalies found in current data, including those from space probes, to gain an appreciation for the difficulties encountered as scientists try to "fit the pieces" into the overall picture. They will then use these data to make predictions.

Plasma Wars
- Teacher guide
- Student Text
- Student Activity
- Student Handout

Ouch! That Hurts!
- Teacher Guide
- Student Text
- Student Activity

Development

In following activities students will explore:

- Planetary data that has the greatest consensus of interpretation by astronomers. In the activity, "Are We Related?" students look for patterns in planet diversity. Students will be looking for evidence that differences in planetary characteristics are related to their distances from the sun.
- Differences in planetary magnetospheres in "Plasma Wars," impact cratering in "Ouch! That Hurts!" and greenhouse effects in "Hot and Cold Running Planets" using models to study the influence of planetary atmospheres on their formation and evolution.
- Stochastic (random) processes and their possible relevance to the origin of planetary diversity in "Out of Chaos."

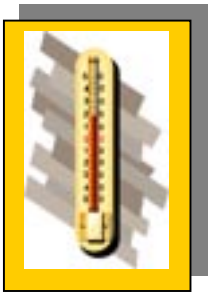
Out of Chaos
- Teacher Guide
- Student Text
- Student Activity
- Student Data Sheets

Hot & Cold Running Planets
- Teacher Guide
- Student Activity

Greenhouse Effect
- Student Text

Interaction/Synthesis

Students interact with peers to accomplish the tasks assigned in the Exploration and Development sections above. Each activity contains work to be done in groups, with the whole class participating in preliminary and summary discussions.



Missing Planet
- Teacher Guide
- Student Activity

Assessment

The known planets are spaced fairly regularly around the sun, but there is an obvious gap between Mars and Jupiter. All the mathematical formulae for modeling the distances of the planets from the sun suggest that there should be a planet somewhere between 2.8 AU and 3.5 AU. At this distance, however, we have found more than 4000 asteroids rather than a planet.

The position of the asteroid belt in space is the transition point between the terrestrial planets and the large gaseous planets. Prediction of the properties of the planet that could have formed in the asteroid belt, "the missing planet," provides an interesting question to pose for students' consideration as the final assessment activity of this Planetary Diversity module.

Curriculum Connections
National Standards Addressed

Assessment Standard B
Achievement and Opportunity to Learn Science must be Assessed

Assessment Standard C
Assessment Tasks Are Authentic

TEACHER RESOURCES

View a listing of additional resources that includes URLs, books, and periodicals.

This education module, *Cosmic Chemistry: Planetary Diversity*, was developed by educators at Mid-continent Research for Education and Learning.

McREL

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Special thanks to the following reviewers:
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Gil Yanow, Jet Propulsion Laboratory
Howard Schaeffer, LaPorte (TX) H.S.
John Ristvey, McREL
Alice Krueger, McREL
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