

## Exhibition Guide for a Field Trip to the Koshland Science Museum

### *Global Warming Facts & Our Future Focus*

#### TABLE OF CONTENTS

INTRODUCTION .....	1
The Museum’s Exhibitions .....	2
EDUCATIONAL OBJECTIVES AND PROCEDURES.....	2
A Step-By-Step Agenda for a Class Visit.....	2
The Role of the Field Trip Leader, Teachers, and Chaperones .....	5
MAKING THE MOST OF YOUR MUSEUM VISIT .....	5
PROCEDURES FOR SIGNING UP FOR A FIELD TRIP.....	6
THE CONTENT OF THE <i>GLOBAL WARMING FACTS &amp; OUR FUTURE</i> EXHIBITION .....	7
HOW IS THE MUSEUM EXPERIENCE CORRELATED WITH THE NATIONAL SCIENCE EDUCATION STANDARDS? .....	9
For Middle School Students.....	9
For High School Students .....	10

#### INTRODUCTION

Welcome to the Koshland Science Museum. A visit to the museum is a unique experience. The Koshland Science Museum covers current issues in the headlines and provides scientific information that can be used to make decisions that affect visitors’ daily lives. The information is presented in highly interactive exhibits.

Your class visit to the museum has been designed to model good learning and teaching practices. Using the Jigsaw method described below, your class will divide into smaller groups that will visit different parts of the museum. Together, the members of the groups will become “experts” as they seek information to share with their classmates during small-group and whole-class discussions. Students will collaborate in thinking about evidence and formulating ideas much like scientists do in their daily work.

Your visit to the museum will last approximately two hours. During that time, your class will study in detail the *Global Warming Facts & Our Future* exhibition. Your class also will spend some time with the museum’s *Wonders of Science* and *Putting DNA to Work* exhibitions. All class visits must be scheduled in advance due to limited space.

## **The Museum's Exhibitions**

The museum has three exhibitions.

The *Wonders of Science* exhibition asks, "What's the Universe made of?" It encourages visitors to think about some of the big unsolved questions in science, fostering creative thinking and a sense of wonder about the universe. All students will visit this exhibition briefly and ponder the questions it poses.

The *Putting DNA to Work* exhibition introduces students to DNA sequencing and to some of the applications of this technique. The applications explored include genetic testing, disease identification, forensics, and crop improvement. Your students will visit this exhibition briefly and consider some of the broad issues it raises.

The *Global Warming Facts & Our Future* exhibition uses interactive displays to present evidence about natural climate variability and the effects of human activities on climate. The exhibition also provides tools for visitors to explore the consequences of climate change and potential responses to climate change. This is the exhibition where your class will focus most of its attention.

## **EDUCATIONAL OBJECTIVES AND PROCEDURES**

The Koshland Science Museum embodies the inquiry-based approach to education set forth in the *National Science Education Standards* (National Research Council, 1996). By asking questions, gathering information, formulating explanations, and communicating those findings to others, students develop critical and logical thinking skills. Class visits to the museum also reflect current understanding about the processes of learning, as described in *How People Learn* (National Research Council, 2000). Active learning in collaborative teams combined with peer teaching gives students a powerful and meaningful experience with the information and ideas they encounter.

Your class's overall objective will be to address the following question:

***What evidence can be used to guide decisions related to climate change?***

To break down this question into manageable parts, the students will divide into groups and gather information from a specific part of the *Global Warming Facts & Our Future* exhibition. They then will communicate their findings and conclusions within their groups and to the entire class.

### **A Step-By-Step Agenda for a Class Visit**

#### **1. Orientation (15 minutes)**

A trained field trip leader will join your class to describe the mission to be accomplished over the following two hours. With the assistance of the teacher and adult chaperones, the field trip leader will manage the flow of the class through the museum and guide the class discussion. Classes should arrive 10 minutes before their start time to enter the building and congregate in the area where the orientation will occur. (Note: The time allotments shown include the time required to move from one stage of the visit to the next.)

2. Touring the Exhibitions (50 minutes)

You will assign your students in three groups: red, yellow, or blue (see the Group Assignment Form). Each group will cycle through three rotations in the museum. During one rotation, they will become experts in one aspect of the *Global Warming Facts & Our Future* exhibition. During another rotation, they will tour the *Wonders of Science* exhibition and the general information areas in the *Global Warming Facts & Our Future* exhibition. During the third rotation, they will visit the *Putting DNA to Work* exhibition. Thus, in two of the three rotations, students will be reading the big messages of the exhibitions and briefly using the interactive displays. In the third rotation, students will be digging more deeply into a subject to build a base of knowledge that they will use during the group discussions later in their visit.

For your visit to the *Global Warming Facts & Our Future* exhibition, the rotations will be as follows (in this schedule the gray boxes are the rotations where each group will study a particular topic in detail):

<b>Groups</b>	<b>Rotation #1</b>	<b>Rotation #2</b>	<b>Rotation #3</b>
<b>Yellow</b>	<ul style="list-style-type: none"> <li>• <i>Wonders of Science</i></li> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– Greenhouse Effect</li> <li>– Climate Change Hits Home</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– The Carbon Cycle</li> <li>– Causes of Climate Change</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Putting DNA to Work</i></li> </ul>
<b>Blue</b>	<ul style="list-style-type: none"> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– A Changing But Uncertain Future</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Putting DNA to Work</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Wonders of Science</i></li> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– Greenhouse Effect</li> <li>– Climate Change Hits Home</li> </ul> </li> </ul>
<b>Red</b>	<ul style="list-style-type: none"> <li>• <i>Putting DNA to Work</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Wonders of Science</i></li> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– Greenhouse Effect</li> <li>– Climate Change Hits Home</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Global Warming Facts &amp; Our Future</i> <ul style="list-style-type: none"> <li>– The History of Climate Change</li> </ul> </li> </ul>

Each student will receive a clipboard, pencils, and two worksheets. The first worksheet will facilitate analysis of the “Greenhouse Effect” and “Climate Change Hits Home” areas in the *Global Warming Facts & Our Future* exhibition. The second worksheet, which is tailored to each of the three groups, will help the Expert Groups analyze in detail the area they are assigned. Because your class is focusing on the *Global Warming Facts & Our Future* exhibition, your

students will not receive worksheets on either the *Wonders of Science* or the *Putting DNA to Work* exhibitions.

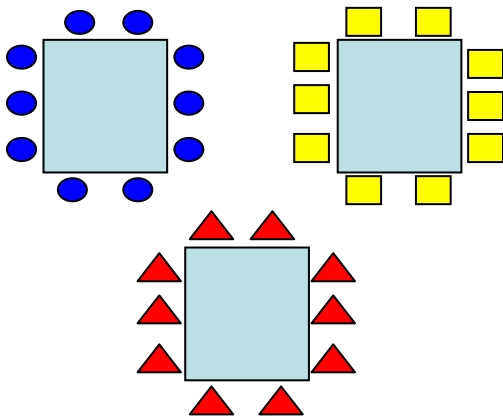
Students should use their worksheets to record any questions they have about any of the data or other information presented. Students also can ask questions of the field trip leader.

### 3. Expert-Group Discussions (15 minutes)

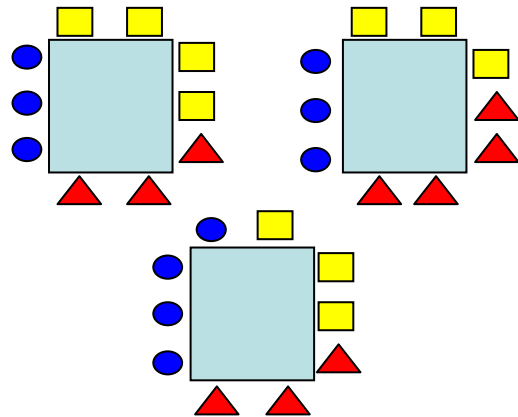
After the students have cycled through all three rotations, each Expert Group will move to a discussion area where they will meet separately to discuss the topic they were assigned to analyze in detail. Working together, each Expert Group will prepare their main points to present during the following Interdisciplinary-Group discussions. By working cooperatively, each of the students in the Expert Groups can become knowledgeable in that area. Students will be responsible for summarizing the material discussed by the Expert Groups in subsequent group discussions.

### 4. Interdisciplinary-Group Discussions (15 minutes)

Next, the students in the Expert Groups will be redistributed to form three new “Interdisciplinary Groups.” (The Interdisciplinary Groups correspond to the numbered groups on the Group Assignment Form.) Each member of the Interdisciplinary Groups will share some of the main points learned earlier and discussed in the Expert Groups. The Interdisciplinary Groups will think about the major question they have been asked to address and will formulate recommendations or suggestions for action. The Interdisciplinary Groups will discuss key pieces of evidence that support their conclusions. The groups also may outline possible additional research questions that need to be answered.



**Expert Group Example**



**Interdisciplinary Group Example**

## 5. Plenary Discussion (25 minutes)

Your visit to the museum will conclude with a discussion involving the entire class and guided by the field trip leader. The discussion will center on the major question being addressed by the class:

### ***What evidence can be used to guide decisions related to climate change?***

Students will synthesize the discrete information they have learned into a “big picture.” The class will discuss the types of decisions that current evidence can support. The discussion should be focused on the applicability of the evidence to each decision, keeping in mind the uncertainties associated with unknown aspects of human behavior, climatic modeling, and natural variability.

The Jigsaw method requires that students become actively engaged with the information they are studying and that they develop an understanding sufficient to enable them to share their understanding with other classmates and make informed recommendations. Students with some experience in working collaboratively and taking responsibility for their own learning will have the most to gain from the visit. Pre- and post-visit materials will offer guidance to teachers to enhance the value of the museum visit to their students.

## **The Role of the Field Trip Leader, Teachers, and Chaperones**

During your class visit, the field trip leader will:

- Instruct your class on its mission.
- With your assistance, manage your class’s flow through the museum.
- Lead the class discussion after the Expert-Group and Interdisciplinary-Group discussions.
- Encourage comments based on evidence.

Teachers and chaperones are asked to:

- Help promote students’ inquiry.
- Prepare their classes for the visit.
- Maintain appropriate behavior of students.

## **MAKING THE MOST OF YOUR MUSEUM VISIT**

To help ensure a successful visit:

- Prepare your students for their museum visit based on the information in this and other documents available on the museum’s web site and that you receive when you register for your class’s visit.
- Have your students leave backpacks, portable devices and other items on the bus or at school.

- Discuss appropriate behavior with your students ahead of time. Remember, the museum is housed in the Keck Center, the workplace of the National Research Council.
- Refer to the group visits section of the Koshland Science Museum web site for information in motorcoach parking.
- Have enough chaperones for a ratio of no more than ten students to one chaperone.
- Read through the science content of the exhibition you are studying in detail. Think about how the visit will fit into your curriculum.
- Have your class carry out some of the pre-visit activities suggested on the web site.
- Assign students to Expert and Interdisciplinary Groups using the Group Assignment Form prior to the visit. Each group should have a student leader. Each group will tour the exhibits together and become an expert in one of the three rotations of the exhibition you are studying in detail. The student group leader may help delegate tasks where appropriate.
- At the end of your visit, contribute comments on the postcards provided, including one new thing that was learned and offering suggestions to improve the museum experience. After the museum staff use the postcards to evaluate the program offered, they will mail the postcards to your school.

## **PROCEDURES FOR SIGNING UP FOR A FIELD TRIP**

All field trips must be scheduled in advance due to limited space. Field trips are offered in the morning on Tuesday, Wednesday, and Thursday and in the afternoon on Tuesday (subject to availability). Field trips are limited to 35 or fewer students due to the nature of the experience. Unscheduled visits by school groups will not be offered the field trip program.

To request a field trip:

1. Complete the online field trip request form at <http://www.koshlandscience.org/teachers/fieldtripform.jsp> or call 202-334-1201. Requests must be submitted at least four (4) weeks in advance of the requested date. You will be contacted within two (2) business days to confirm available dates.
2. Schools from the greater DC metropolitan area are free. The greater DC metropolitan area is defined as Washington DC, Montgomery County MD, Prince George's County MD, Charles County MD, Arlington County VA, Fairfax County VA, Prince William County VA, Loudon County VA and all cities and towns within these counties.
3. For groups from outside the greater DC area, admission payment is required to finalize your reservation. See the Group Payment, Refund, and Cancellation Policy for details on payment.
4. Once your field trip is confirmed you will receive a field trip packet in the mail. This contains the Exhibit Guide, the Group Assignment Form, a sample of the Student Worksheets, and the Roles and Responsibilities of Student Leaders. Please review this information carefully and contact the museum's education office at (202) 334-1201 with any questions or concerns.
5. At least two (2) weeks before your field trip, please finalize all arrangements with your school district, send out field trip permission forms to your class's parents, and arrange for chaperones.

6. One (1) week before your trip you must return our completed Field Trip Group Assignment form. Failure to return the form will result in the cancellation of the field trip for schools in the greater DC area. Hand out the Roles and Responsibilities of the Student Leader sheet out to the students you selected as student leaders.

## **THE CONTENT OF THE *GLOBAL WARMING FACTS & OUR FUTURE* EXHIBITION**

The *Global Warming Facts & Our Future* exhibition presents current knowledge about the potential causes and impacts of climate change and about potential human responses to mitigate its harmful effects. The exhibition is divided into five stations, each with information and interactive experiences for students.

### **Station 1: The Greenhouse Effect**

The main messages of station 1 are:

- Human influence on the natural climate system is leading to a changing but uncertain future.
- The greenhouse effect is a natural phenomenon that warms the Earth.
- The greenhouse effect is amplified by increased concentrations of greenhouse gases.
- There is a range of international perspectives on climate change.

The centerpiece of this station is a hands-on demonstration illustrating the natural greenhouse effect and the role of higher greenhouse gas (GHG) concentrations in amplifying the warming. Students actually feel the warming effect of increased trapping of infrared radiation.

### **Station 2: The Natural Carbon Balance and Causes of Climate Change**

The main messages of station 2 are:

- The natural Earth system maintains a carbon balance.
- Human carbon dioxide (CO<sub>2</sub>) emissions will disrupt the balance for a long time.
- Forcing/feedback interactions make the climate dynamic.
- Greenhouse gases are the primary forcing factor.
- The natural climate system is complex but has identifiable elements.
- Natural climate changes illustrate forcing and feedback.
- Climate changes affect human events.
- The paleoclimatological record can be read in tree rings, ice, sediment, coral, and other forms of evidence.

The centerpiece of this station is a large, permanently sealed glass sphere containing an ecosystem that persists because of the cycling of carbon and other chemicals. This station demonstrates that carbon is cycled through living systems as part of the Earth system, which controls Earth's climate. The exhibit builds understanding of the components of the natural climate system and the role played by CO<sub>2</sub> in that system. It also presents evidence for changes in levels of CO<sub>2</sub> that correlate with human activities. The station asks students to consider factors that influence the natural system, and two unique timelines offer evidence regarding past climates. This station also presents evidence of past impacts of climate change on society.

### **Station 3: A Century of Change**

The main messages of this station are:

- The increases in atmospheric CO<sub>2</sub> levels and temperature are real.
- “The changes observed over the past several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability” (National Research Council, 2001).
- Twentieth-century temperature changes are locally varied.
- Contemporary observation techniques yield greater spatial and temporal resolution than does paleoclimatic evidence.
- CO<sub>2</sub> and other greenhouse gas emissions arise from a variety of sources.
- While CO<sub>2</sub> is the most significant greenhouse gas, other powerful greenhouse agents might be controlled less expensively in the near term.

The centerpiece of this station is a large glass timeline showing the relationship between temperature and CO<sub>2</sub> during the 20<sup>th</sup> century. Students can slide a plasma screen along the timeline to view an animation of temperature change over the 20<sup>th</sup> century. An interactive element allows students to examine regional temperature changes by year. Other displays include a description of the various sources of greenhouse gas emissions.

#### **Station 4: A Changing but Uncertain Future**

The main messages of this station are:

- Despite variation among models, almost all agree that CO<sub>2</sub> concentrations and temperature will continue to rise.
- Uncertainties in the details of climate projections are due to uncertainties in human behavior, models, and natural variability.
- U.S. residents currently account for significantly higher emissions of CO<sub>2</sub> on average than do people in most other countries.
- Future atmospheric CO<sub>2</sub> levels depend on human choices.
- Projecting future human emissions involves uncertainties about geo-economic and geo-political forces.
- CO<sub>2</sub> emissions are unevenly distributed among nations and regions. The nature of the uneven distribution depends on whether emissions are measured as total emissions, emissions per unit of gross domestic product, or emissions per person.
- The distribution of emissions will change in the next 20 years.
- Effective mitigation would likely require both personal and corporate action.
- Some mitigation actions are more effective than others.
- Stabilizing atmospheric CO<sub>2</sub> at today’s level would require approximately a three-quarters reduction in emissions.

This station uses computer-modeling systems to project possible scenarios given various forecasts of CO<sub>2</sub> emissions. Students also will see how human choices can influence the future through choices affecting population sizes, the economy, and technology. Current and projected future CO<sub>2</sub> emissions from various nations are presented in graphic format. Using a computerized tool, students will be able to assess the effectiveness of personal and national choices.

### **Station 5: Climate Change Hits Home**

The main messages of this station are:

- “Despite the great uncertainties, greenhouse warming is a potential threat sufficient to justify action now” (National Research Council, 1992).
- Climate change will affect many aspects of human life and ecology.
- There will be large regional differences in impacts and in the ability to respond to climate change.
- Mitigation and adaptation responses involve compromises that affect personal lifestyles and national and international policy.
- Choices regarding possible responses vary from person to person.

In this station, students consider the impact of climate change on different geographic regions. For example, a large interactive display allows students to see what would happen if the sea level rises due to a warmer climate, and students are asked to think deeply about the possible impacts resulting from such a sea level rise. This station confronts students with the need for analytical thinking and problem solving to make decisions related to climate change.

### **HOW IS THE MUSEUM EXPERIENCE CORRELATED WITH THE NATIONAL SCIENCE EDUCATION STANDARDS?**

Field trips to the Koshland Science Museum are modeled on recommendations made in the *National Science Education Standards* (National Research Council, 1996). Through the information presented and opportunities to interact with hands-on displays, the *Global Warming Facts & Our Future* exhibition meets the following Inquiry and Science Content standards.

#### **For Middle School Students**

- **Content Standard A – Understanding about Scientific Inquiry**  
“Think critically and logically to make the relationships between evidence and explanations”
  - During the Interdisciplinary-Group and whole-class discussions, students think critically and logically to draw links between evidence and explanations. They do this by teaching their peers and by considering the evidence that can be used to guide decisions related to climate change.
- **Content Standard B - Physical Science**  
“Students should develop an understanding of **properties of matter, motion and forces and transfer of energy**”
  - Station 1 demonstrates the transfer of energy through a model with which students can actually feel the “greenhouse effect.” Station 2 provides students with an opportunity to better understand some of the ways that the motion of the Earth, variation in solar emission, variation in ocean circulation, and changes in greenhouse gases and aerosol concentrations in the atmosphere contribute to changes in Earth’s

climate. The ultimate effect of energy transfer is shown through the global warming data presented in stations 3 and 4.

- **Content Standard C – Life Science**  
“Students should develop an understanding of **regulation and behavior and populations and ecosystems**”
  - Students develop a deeper understanding of populations and ecosystems in stations 4 and 5 as they learn about possible impacts of global climate change and changing ecosystems. The changing but uncertain future predicts adaptations among organisms and populations as temperature and water availability fluctuates.
  
- **Content Standard D - Earth and Space Science**  
“Students should develop an understanding of **earth in the solar system**”
  - Through data and information presented in stations 2 and 3 on global atmospheric patterns and the role of oceans in the changing climate system, students develop a better understanding of the structure of the Earth system, Earth’s history, and Earth in the Solar system. Students also learn that solar energy is the main source of energy on Earth and that climate patterns, seasons, and ecosystems depend on the input, transformation, and retention of solar energy.
  
- **Content Standard E – Science and Technology**  
“Students should develop understandings about **science and technology**”
  - Students develop a better understanding about science and technology as they see the many ways in which scientists have collected data and have made predictions about future climate change. This is best seen in stations 4 and 5 where methods of data collection and analysis are explained. Data from the last century are used in computer models to understand patterns of the past.
  
- **Content Standard F – Science in Personal and Social Perspectives**  
“Students should develop understanding of **natural hazards and risks and benefits**”
  - Students gain a better understanding of natural hazards as they relate to global climate patterns. As students think about potential impacts of climate changes, they are challenged to think about estimating rates of change, types of natural disasters and possible locations of those disasters. Stations 4 and 5 provide opportunities to consider possible future events.
  
- **Content Standard G – History and Nature of Science**  
“Students should develop an understanding of **science as a human endeavor and nature of science**”
  - All of the stations describe human endeavors to understand the climate system and to use that understanding to predict future events.

## **For High School Students**

- **Content Standard A – Understanding about Scientific Inquiry**  
 “Students should develop understandings about **scientific inquiry, recognize and analyze alternative explanations and models and communicate and defend a scientific argument**”
  - Through the “use of empirical standards, logical argument and skepticism” students analyze the data presented, evaluate how the data were generated, and consider the validity and significance of the data in predicting potential global climate change. By using evidence to support and defend their positions in both small- and large-group discussions, students think logically and critically about potential future consequences of global climate change.
  
- **Content Standard B – Physical Science**  
 “Students should develop understanding of **chemical reactions, conservation of energy and the increase in disorder, and interactions of energy and matter**”
  - In station 1, students explore the role of greenhouse gases in natural and amplified warming. Station 2 explores evidence of human impacts and changing CO<sub>2</sub> levels and allows students to apply their knowledge of dynamic systems, data analysis, and the interactions of matter and energy. In station 3, students look at methods of collecting evidence and ways of interpreting evidence. Station 4, using computer modeling, applies knowledge of chemical interactions and the consequences of those interactions to forecast a changing but uncertain climatic future.
  
- **Content Standard C – The Cell**  
 “Students should develop understanding of **the interdependence of organisms, and matter, energy & organization in living systems**”
  - In stations 2, 3, and 4, students explore how the carbon cycle, cellular functions, chemical reactions, and human population size and activities affect the environment. Data from prehistoric climates allow students to apply their understanding of matter, energy, and organization in past living systems to think critically about the impacts of human behavior. Students use models to predict the effects of future climate change on health and disease, agriculture, changing water resources, and loss of biodiversity.
  
- **Content Standard D – Earth and Space Science**  
 “Students should develop an understanding of **energy in the earth system**”
  - All of the stations give students a chance to work with scientific evidence regarding the effects of the Earth’s energy balance on climate. Students investigate evidence for global warming through deep time, collect data on past changes, and compare those data with more recent data and with changes in human population sizes and activities.
  
- **Content Standard E – Science and Technology**  
 “Students should develop **understandings about science and technology**”
  - All of the stations provide opportunities for students to gather and analyze data developed by technological advances and modeling of systems. Students see how the amounts and forms of data increase as new technologies are developed and employed.
  
- **Content Standard F – Science in Personal and Social Perspectives**

“Students should develop understanding of **environmental quality, natural and human induced hazards, science and technology in local, national and global challenges**”

- All of the stations allow students to work in collaborative teams to collect data, think about the implications of the data, and consider potential future global challenges. After students understand the science, they have opportunities to discuss implications for public policy, politics, and economics.

- **Content Standard G – History and the Nature of Science**

“Students should develop an understanding of **science as a human endeavor and nature of scientific knowledge**”

- In all of the stations, students learn that scientists share their methods and data, review each other’s work, and come to differing conclusions about results. Working as scientists, students discuss the data provided, share their interpretations, pose additional questions, and debate the significance of an uncertain future global climate.