NOVA follows a team of climbers ascending Denali to try to solve the mystery of why extreme cold and high altitude can kill.

The program:
- outlines the expedition’s mission to monitor team members’ physiological states as they trek to the mountain’s peak, the highest in North America.
- points out that each climber ingests a radio thermometer pill that continuously logs core body temperature.
- reviews the environmental conditions on Denali, one of the coldest mountains on Earth.
- relates an experiment that details what happens to core body temperature when a climber rests after a vigorous climb.
- describes illnesses that can affect mountain climbers, including hypothermia, hyperthermia, Acute Mountain Sickness (AMS), and High Altitude Pulmonary Edema (HAPE).
- notes the results of one altitude study that revealed that the use of ginkgo reduced symptoms of AMS.
- chronicles several rescue attempts undertaken to aid climbers in danger on the mountain.
- relates how oxygen saturation levels are affected during a mountain climb and the problems that can occur when the levels get too low.
- follows the team’s progress as team members attempt to summit the mountain.
- notes that scientists are coming closer to understanding the limits of survival in extremely cold, high-altitude environments.

Taping Rights: Can be used up to one year after the program is taped off the air.

BEFORE WATCHING

1. Draw a chart on the board that shows the relationship between altitude and atmospheric pressure (see Background on page 2 for chart). Explain that atmospheric pressure is related to the strength of Earth’s gravitational pull. The farther away from the center of the Earth, the weaker the gravitational pull. The air molecules (including oxygen) high on a mountain are less dense per square inch so they exert less pressure on the human body.

2. Organize students into four groups and have them take notes on the following topics: weather conditions during the climb, health issues that arise, the team’s responses to the changing conditions, and important decisions made by the team during the climb.

AFTER WATCHING

1. Have students who took notes on the same topics meet, compare their notes, and share what they learned.

2. In the program, the physiological conditions related to AMS and HAPE are discussed. Have students describe how low oxygen levels and/or cold cause or influence these conditions. (AMS is mainly a physiological response to low oxygen; both cold and low oxygen contribute to HAPE.)

3. Making a decision to climb a high-elevation mountain involves risk, resources, and much preparation. Make a three-column chart on the board and label the columns Groundwork and Preparations, Potential Risks, and Potential Rewards. Have students fill in the chart with information they learned from the program.
CLASSROOM ACTIVITY

Activity Summary
To learn more about some of Earth’s extreme environments and some of the possible dangers they present.

Materials for Each Student
• copy of the “Going to Extremes” student handouts (2 pages)
• copy of the “Extreme Survival” student handout
• copy of the “Extreme Questions” student handout

Background
Climbers who ascend Denali (Mt. McKinley) can experience health problems in response to extreme conditions—high altitude, low atmospheric pressure, and severe cold. The mountain is 6,194 meters from its base to its summit. Most humans are adapted to living on Earth’s surface where air pressure is about 14.7 pounds per square inch. At high elevations, because there is less oxygen in a given amount of air, humans who are not acclimated to the environment experience hypoxia, or oxygen deprivation, and its consequences due to low air pressure, and they experience health complications such as hypothermia, frostbite, and sometimes gangrene due to intense wind and cold. This chart shows some air pressures at different elevations:

<table>
<thead>
<tr>
<th>Altitude* (in meters)</th>
<th>Barometric Pressure* (in centimeters)</th>
<th>Barometric Pressure* (in Atmospheres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (sea level)</td>
<td>76 cm</td>
<td>1</td>
</tr>
<tr>
<td>5,486 m</td>
<td>38 cm</td>
<td>.5</td>
</tr>
<tr>
<td>10,668 m</td>
<td>18 cm</td>
<td>.24</td>
</tr>
<tr>
<td>15,240 m</td>
<td>9 cm</td>
<td>.12</td>
</tr>
<tr>
<td>18,288 m</td>
<td>5 cm</td>
<td>.07</td>
</tr>
<tr>
<td>22,860 m</td>
<td>2.5 cm</td>
<td>.03</td>
</tr>
<tr>
<td>28,956 m</td>
<td>0.8 cm</td>
<td>.01</td>
</tr>
</tbody>
</table>

* pressures are approximate

Mountains are only one example of extreme environments. Others include jungles, deserts, oceans, arctic regions, and space. In this activity, students will learn more about some of these environments.

LEARNING OBJECTIVES
Students will be able to:
• identify conditions of some of the world’s extreme environments.
• describe some of the potential dangers found in extreme environments around the world.
• state some of the ways to deal with potential dangers in extreme environments.

STANDARDS CONNECTION
The “Going to Extremes” activity aligns with the following National Science Education Standards.

Grade 5-8
Science Standard F
Science in Personal and Social Perspectives
Personal health
Risks and benefits

Video is not required for this activity.

Classroom Activity Author
Developed by WGBH Educational Outreach staff.
CLASSROOM ACTIVITY (CONT.)

Procedure
1. Distribute copies of the handouts to each student.
2. Have students read the handouts and then answer the questions on their “Extreme Questions” handout. Ask for volunteers to share answers to each question with the entire class.
3. As a class, categorize the dangers and risks presented for each environment. Discuss with students which of the dangers can become life threatening. Which dangers are avoidable? What could be most easily avoided? How? Which dangers seem unavoidable?
4. As an extension, have students explore some of the scientific research being conducted in extreme environments, including environments not listed on the handout (i.e., in arctic regions, inside volcanic craters, and in space). Ask students to choose a research topic and create a poster that describes the environment's conditions, the research being conducted, and what scientists hope to learn.
ACTIVITY ANSWER

1. Where are you likely to be vulnerable to both hyperthermia and hypothermia? Grand Canyon: hyperthermia from hiking (especially during summer months deep in the canyon), hypothermia from freezing nighttime temperatures (particularly during the winter months); Pacific Ocean: hyperthermia from extended sun exposure, hypothermia from cold nighttime temperatures or deep ocean dives; Denali: hyperthermia from overexertion, hypothermia from freezing temperatures.

2. You have been bitten by an Anopheles mosquito and now have fever and chills. What’s wrong with you and what should you do? You have malaria. If you didn’t take chloroquine prior to your trip, you should see a doctor as soon as possible for antimalarial drugs.

3. Oh your aching head. And dizzy body. And nauseous stomach. Luckily, a doctor is nearby. She diagnoses you with AMS. Where are you? Should you stay there or go somewhere else (and if so, where)? You are high on Denali. Your symptoms will go away if you descend to a lower altitude.

4. Your brain tells you that the world looks nice and stable. Your inner ear says everything is pitching up and down. What’s happening to you? You are suffering from seasickness or motion sickness.

5. What is that taste in your mouth? Tastes like you bit into something rubber. You don’t remember eating your bike tire, so what could it be? What should you do about it? You are reacting to the poison from a western diamondback rattlesnake bite. You should keep the bite area lower than the heart and place a constricting bandage between the bite and the heart before heading to a hospital.

6. You are in the desert and have developed hyponatremia. What could you have done to prevent this? Hyponatremia (water intoxication caused by drinking too much water, which dilutes sodium in the bloodstream) can be prevented by reducing further intake of water and replacing the lost salt.

7. Brrrrrrr. It’s really cold down here. You are 30 meters below sea level. Before you came down here someone told you to be careful about getting Caisson’s disease. What is that? What other dangers do you face in this location? The person was referring to decompression sickness, or the bends, which is also known as Caisson’s disease. This occurs when a diver swims to the surface too rapidly. Other dangers faced here include hypothermia and nitrogen narcosis.

8. Snails may look pretty harmless when they are slithering by on your sidewalk. But there’s one snail that you should avoid at all costs. Why would that be and where would you have to travel to find it? You would want to avoid the river snail because it causes schistosomiasis. It is found in Amazon rivers.

Links
NOVA Web Site—Deadly Ascent
www.pbs.org/nova/denali
Find articles, interactive activities, and resources in this companion Web site to the program.

Desert Survival
www.ci.phoenix.az.us/fire/desert.html
Explains how to survive in a desert environment.

High-Altitude Medicine
www.aafp.org/afp/980415ap/harris.html
Describes medical conditions that can occur in high-altitude environments.

Nitrox Scuba Diving
www.online.uillinois.edu/oakley/nitrox.html
Reports on decompression sickness and potential remedies that lessen the effects of nitrogen when scuba diving.

Books
Mount McKinley: Icy Crown of North America
by Fred Beck.
Contains routes of specific Denali climbs, historical photos, a record of accidents, and an analysis of problems climbers have encountered.

Surviving the Extremes: A Doctor’s Journey to the Limits of Human Endurance
by Kenneth Kamler.
Details stories of human endurance in a jungle, a desert, the high seas, underwater, and outer space.

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Going to Extremes

The world offers many exciting places to travel. But some of the world’s most beautiful places—rainforests, deserts, deep ocean environments, and mountaintops—are also the most remote. Many of these environments require extreme caution. In this activity learn about some of the extreme places you can go on Earth, some of the dangers you can encounter, and some of the ways you can deal with those dangers.

Grand Canyon National Park
Arizona, United States
Get your hat out, because if it’s summer, it’s going to be hot. In July, maximum temperatures range from 25° to 41° C, depending where you are in the canyon. Despite the heat, the park is home to a diverse range of species, including 50 species of reptiles. You should watch out for some of those creatures, particularly the rattlesnakes. If you are one of the unfortunate few people to get bitten by the most common rattlesnake, the western diamondback, you will likely have a rubbery taste in your mouth, and feel weak and nauseous when the poison enters your bloodstream. Dehydration is one of the biggest threats here. Drink plenty of water to replenish what you lose due to sweating but watch out for hyponatremia. Be careful when you hike as well; don’t hike the inner gorge in the summer when you may get hyperthermia. If you’re hiking during the winter months, make sure you bring cold weather gear, for night temperatures are cold enough to cause your core body temperature to drop below 35° C. During the day, you will surely want to get pictures of the unique variety of rocks and geological features. But be careful of those rocks; they can form rock landslides. And if there is a storm, watch out for lightning strikes or flash floods.

Pacific Ocean
The Pacific Ocean covers more than one-third of the Earth’s surface. It is filled with interesting geological features, including plateaus, ridges, trenches, and seamounts. If you decide you want to go scuba diving to see some of those, remember that water conducts body heat much faster than air of the same temperature. If you dive too deep for too long, your body temperature will drop below 35° C. You’re also subject to other dangers while you’re down there, including nitrogen narcosis if you stay down too long, and Caisson’s disease if you ascend too rapidly. If you decide to do some deep-sea fishing, better make sure you have some protection from the sun. If you get caught adrift and experience extended exposure, your body temperatures can rise above 41° C. If night falls and you don’t have warm clothes or blankets, you face a different problem—cold temperatures that put you at risk for hypothermia. And at any time of the day, you are subject to hazards that include typhoons and tidal waves. Even under normal weather conditions, ocean wave heights can easily reach eight meters, so take care or you may get mal de mer, where your brain and inner ear have a different take on just how stable the world is.
Welcome to the Amazon, the wettest area in South America. The weather is generally hot and humid throughout the year, with average temperatures ranging from 23° to 33°C. More than one-third of all the species on Earth live here. And some of those can cause you some problems. You should take care to watch out for snakes, jaguars, and piranhas, to name a few. On a smaller scale, it would be good to try to protect yourself from the mosquitoes (particularly the *Anopheles* that causes malaria). You might also see the poison dart frog while wandering around. It was named that for a reason—the poison it emits is so deadly the equivalent of two to three grains of table salt is likely to kill a human. Some of the less deadly dangers you face here are dehydration, diarrhea, and fungus infection. If you travel to the Amazon, it is likely you will want to see the world’s largest water basin, the Amazon River. You can find the biggest freshwater fish in these waters. Called the pirarucu, this fish can weigh 250 kilograms and measure up to 2.5 meters in length. There is something else in these rivers, which while much smaller, may present a bigger problem for you. The rivers contain snails that carry a worm that cause a disease known as schistosomiasis. You will know you have it if you develop a rash or itchy skin, fever, chills, cough, and muscle aches within one to two months of infection.

You have arrived at one of the world’s seven summits, the highest mountains on each of the world’s continents. The National Park and Preserve that contains Denali (also known as Mt. McKinley) boasts more than 2.4 million hectares of land. First climbed in 1913, Denali is 6,194 meters high, making it the highest peak in North America. And with temperatures that can fall below -40°C in winter, it is also one of the coldest mountains in the world. This can give you a serious case of hypothermia. Despite the frigid temperatures, if you exert yourself too much you can get too hot. When this happens, your body’s core temperatures can reach dangerous levels of more than 41°C. If you look around you may spot grizzly bears, wolves, and moose. Careful how close you get to any of those, however, as they could all pose some problems for you. If you decide to try to summit this mountain, be careful as you get to the higher altitudes. If you start to get a headache; lose your appetite; and feel nauseous, weak, and dizzy; you may have Acute Mountain Sickness (AMS). Other dangers here include frostbite, hypoxia, and High Altitude Pulmonary Edema (HAPE).

If there is a word you come across that you don’t understand, try looking for it in the Glossary on your “Extreme Survival” handout.
The best way to defend against the dangers in extreme environments is to be knowledgeable about the challenges the environment presents, to only undertake activities equal to your skill level, and to be as prepared as possible before you ever get there. Here are just a few measures you can take to respond to some of the dangers you may encounter in the extremes.

Try This
If you’ve got malaria, hopefully you took chloroquine prior to your trip to prevent the disease; otherwise get yourself to a doctor for antimalarial drugs. If you have Acute Mountain Sickness, your symptoms will quickly disappear if you descend to a lower altitude. If you decided to go on a deep ocean dive, consider wearing a dry suit to keep you dry and warm (and most importantly, to help guard against hypothermia). Make sure you don’t stay down too long and add decompression stops to your dive so you don’t get the bends. If you’ve been unfortunate enough to have been bitten by a rattlesnake, keep the bite area lower than the heart and place a constricting bandage between the bite and the heart. Then get to a hospital. If you’re in the desert and you get hyponatremia, make sure you limit your intake of water and eat salty foods or consume sports drinks to replace the electrolytes you have used up. If you’re unfortunate enough to have been stricken with mal de mer, there is no quick cure; your best bet will have been to take something before your trip. For hyperthermia, try to stay cool, drink plenty of fluids with electrolytes, and pace yourself. For hypothermia, you should wear proper clothing, make sure your clothes don’t get wet, drink hot liquids, and eat small meals frequently. If somehow you find yourself with schistosomiasis, you can be treated with pills that you take for one to two days.

Glossary
Use this glossary to help you answer your Extreme Questions.

Caisson’s disease: Known commonly as decompression sickness or the bends. At the higher pressures that a diver experiences at deep depths, more gas (oxygen and nitrogen) dissolves in the diver’s blood. If the diver comes up too quickly, the extra dissolved gases come out of the blood as gas bubbles and can cause pain or even death if the bubbles reach the brain or heart.

dehydration: Occurs when the body experiences excessive loss of water.

High Altitude Pulmonary Edema: This illness occurs when the lungs fill up with fluid as a result of the body adapting to high elevation.

hyperthermia: A condition in which normal body core temperature (37°C) rises to about 41°C or more and the body is unable to cool the core temperature down. Severe hyperthermia can cause damage to the body’s vital organs.

hyponatremia: A deficiency of sodium in the blood; left untreated, this condition can lead to seizures and possibly death.

hypoxia: A state of oxygen deficiency that is sufficient to cause an impairment of function in the human body.

mal de mer: French for seasickness, or motion sickness, which happens when your brain receives conflicting signals from your inner ear and eyes. The result: nausea and sometimes confusion.

nitrogen narcosis: A feeling of intoxication that occurs when breathing nitrogen under pressure, such as on a deep ocean dive.

schistosomiasis: A disease caused by parasitic worms that affects 200 million people worldwide. The parasite travels into humans from the snail it breeds in; the worm grows inside the blood vessels of the body and produces eggs that create offspring that are then passed out of the body with waste products.
Read your “Going to Extremes” and “Extreme Survival” handouts. Using the information in these handouts, answer the questions below.

Questions
1. Where are you likely to be vulnerable to both hyperthermia and hypothermia?
2. You have been bitten by an *Anopheles* mosquito and now have fever and chills. What’s wrong with you and what should you do?
3. Oh your aching head. And dizzy body. And nauseous stomach. Luckily, a doctor is nearby. She diagnoses you with AMS. Where are you? Should you stay there or go somewhere else (and if so, where)?
4. Your brain tells you that the world looks nice and stable. Your inner ear says everything is pitching up and down. What’s happening to you?
5. What is that taste in your mouth? Tastes like you bit into something rubber. You don’t remember eating your bike tire, so what could it be? What should you do about it?
6. You are in the desert and have developed hyponatremia. What could you have done to prevent this?
7. Brrrrrr. It’s really cold down here. You are 30 meters below sea level. Before you came down here someone told you to be careful about getting Caisson’s disease. What is that? What other dangers do you face in this location?
8. Snails may look pretty harmless when they are slithering by on your sidewalk. But there’s one snail that you should avoid at all costs. Why would that be and where would you have to travel to find it?