

WALT DISNEY PICTURES  
PRESENTS

A JAMES CAMERON FILM

Educator's Guide

UNSCRIPTED. GROUNDBREAKING. HISTORIC.

# GHOSTS OF THE ABYSS

AN IMMERSIVE 3D ADVENTURE

# A Letter From Director James Cameron

Dear Educator,

Every shipwreck tells a story of tragedy and human loss. The loss goes beyond the lives of those who perished in the sinking, beyond even all those ashore, the friends and family whose lives were shattered. Some shipwrecks are so significant, so meaningful at a symbolic level, their loss can stab deep into the psyche of a nation, of an entire society. The sinking of *Titanic* is one such shipwreck.

The story of *Titanic's* short life and tragic death has enthralled generations since that fateful night in April, 1912, when more than 1,500 people died in the freezing waters of the North Atlantic, on a moonless night under a sky glorious with stars. Although that number has been vastly eclipsed by other catastrophes, the tragedy of *Titanic* has endured to pull at the heartstrings of people all over the world.

In August and September of 2001, I led a new deep-diving expedition in a return to *Titanic*. Our team of underwater explorers made a series of historic dives using revolutionary new camera and lighting equipment to create unparalleled images of the interior and exterior of the wreck. The advanced suite of tools included high-definition 3D cameras, a pair of unique Remotely Operated Vehicles (ROVs), and a specially built deep water lighting platform that illuminated the deep ocean like never before. No other expedition has ever been closer to the *Titanic* wreck than this one.



**Ghosts of the Abyss** tells the story of that expedition, with the dramatic sweep of large-format 3D. This film provides a doorway into history through which to experience the life and death of this amazing ship and the people who were aboard her. In **Ghosts of the Abyss**, the story of *Titanic* is interwoven with the story of our expedition and the dangers and difficulties of deep ocean exploration. Along with the technical team, I brought a select group of historians and scientists to help illuminate the story of this famous shipwreck.

**Ghosts of the Abyss** is a compelling teaching tool. Watching this film in 3D and then taking part in the engaging activities in this guide will motivate your students to learn. Students will explore areas of science and social studies, all of which are linked to national education standards. The guide is designed to lead you and your students to greater insight into the challenges that faced our crew as we explored the world's most famous shipwreck.

Enjoy the adventure!

James Cameron



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### HOW TO USE THIS GUIDE:

The activities in this guide are designed for students in grades 5-8. The guide may be used before or after viewing the film. Activities and material in this guide may be reproduced for use in the classroom.



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# Ghosts of the Abyss: The Expedition

*“When I was young, Titanic was a legend, a myth. It wasn’t until I saw it with my own eyes that it became real. It was a real event that happened to real people.”* – James Cameron, Director



**G**hosts of the Abyss will take you on the 3D journey of a lifetime, more than two miles beneath the surface and into the ruined wreck of the great ship *Titanic*. You will travel to locations unseen for more than ninety years. Through the magic of 3D, you will truly feel as though you are there beside the adventurers as they “fly” their amazing equipment through the ship’s ruined majesty.

James Cameron spent years planning this film and the special equipment he needed to make it. The invention team was led by his brother Mike Cameron. Others on the expedition included: Ken Marschall, *Titanic*’s leading “Visual Historian;” Don Lynch, Chief Historian of the Titanic Historical Society; Bill Paxton and Lewis Abernathy, who performed in the original movie *Titanic*; microbiologist Lori Johnston; biologist and historian Charles Pellegrino; marine archaeologist John Broadwater; and 3D camera designer Vince Pace.

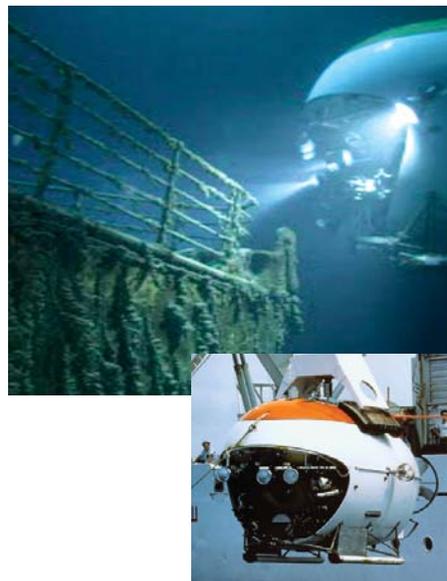


## The Ship

James Cameron’s team worked with the crew of the ship *Akademik Mstislav Keldysh*, operated by Russia’s leading oceanographic research institute. *Keldysh* housed most of the crew and is the mother ship for the two deep-diving submersibles, *Mir 1* and *Mir 2*, that traveled to *Titanic*. The team spent more than six weeks exploring the wreck.

## The Submersibles

*Mir 1* and *Mir 2* are each able to descend 20,000 feet. These subs carried the *Ghosts of the Abyss* team on twelve dives down 2.5 miles beneath the ocean surface to the *Titanic* wreck.

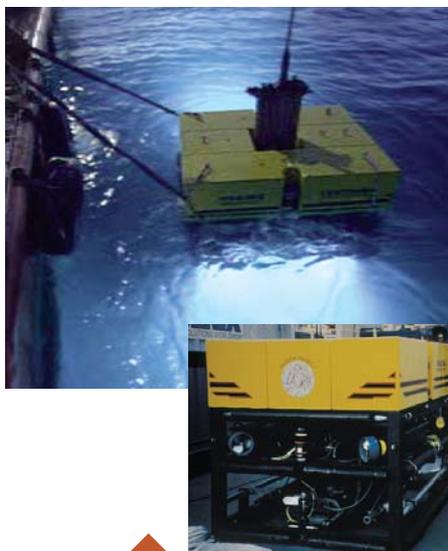


## The Explorers

When James Cameron (left) invited actor Bill Paxton to join the *Ghosts of the Abyss* expedition, he agreed right away. Paxton didn’t actually dive in a submersible when he played Brock Lovett in *Titanic*, and he was a little nervous before diving on this expedition. However, the pilots and the crew were such experts, he soon became comfortable.

### The 'Bots

This is one of two Remotely Operated Vehicles (also called ROVs, 'bots, or simply *Jake* and *Elwood*). They are small, mobile camera systems built to travel throughout almost all of *Titanic's* interior. The ROVs were designed and built by Mike Cameron. Each ROV connects to one of the *Mir* subs by a 2,000-foot fiber optic cable. The cable carries the pilot's commands to the motors and cameras on the ROVs. The same cable carries back video images to the sub.



### Inside a *Mir* Submersible

Most dives made during the expedition lasted about twelve hours. Traveling up and down 2.5 miles in the ocean takes about two hours each way. Though three adults fit in each sub, there is very little room to move around. During a dive, the pilot sits in the center as the passengers lay on their sides on a U-shaped bench. Each passenger looks out through a small porthole, or watches a video monitor. The pilot operates the ROV, too.

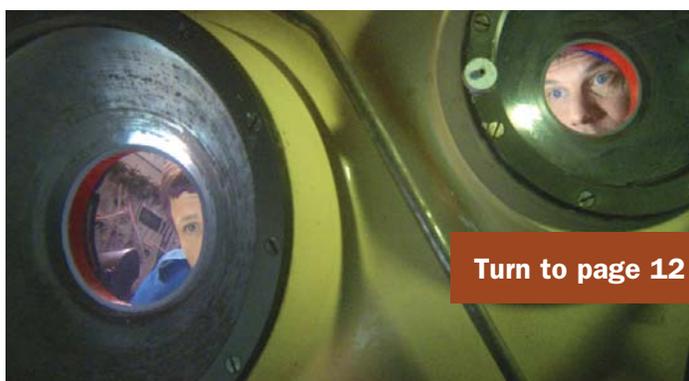


### Medusa Lighting System

To help light up the dark, endless night of the ocean floor, the *Ghosts of the Abyss* team used an ROV called *Medusa*, carrying ten high-powered lights. *Medusa* provided an eerie moonlight effect over the bow deck of the ship.

### The Cowboys

Launch and recovery of the *Mirs* requires precision and caution. Brave divers called "Cowboys" by the *Ghosts of the Abyss* team must uncouple the subs from the lines that carry them down from the ship at launch and reattach these same lines at recovery.



Turn to page 12 for a Social Studies activity based on these pages.

# A *Titanic* Timeline: March 1909 – April 15, 1912



## March, 1909

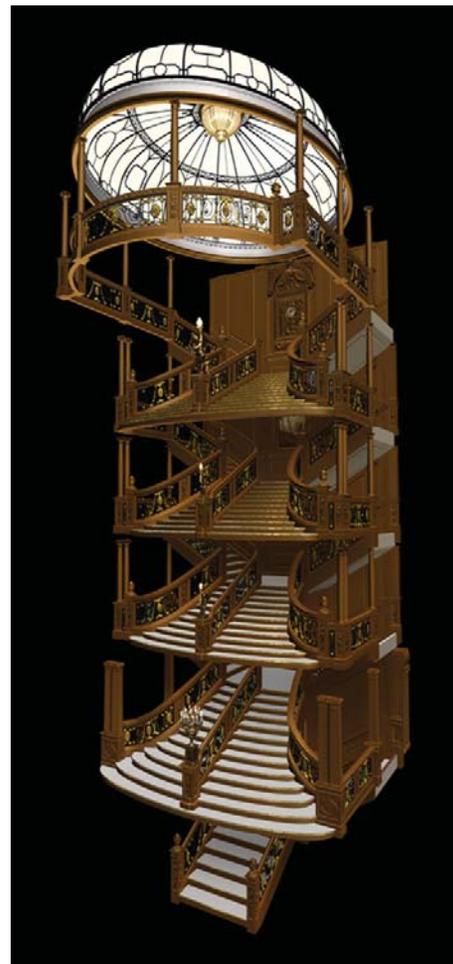
Construction of *Titanic* began in the Irish shipyard Harland and Wolff. *Titanic* and her sister ship, *Olympic*, would be the largest and most luxurious ocean-going vessels of their time. Officials of the White Star Line, which owned both ships, were very proud of their new vessels.

## April 10, 1912

*Titanic* began her maiden voyage, determined to beat the crossing time of sister ship *Olympic* on the voyage from Southampton, England, to New York City. J. Bruce Ismay, Managing Director of the White Star Line, was on board. Captain Edward Smith, a veteran of many transatlantic voyages, agreed to helm *Titanic* as his last crossing. He was due to retire when the ship reached New York.

## April 11-13, 1912

Aboard were about 2,200 people, including many wealthy people, as well as hundreds of second, third and steerage class passengers, and nearly 900 crew members.



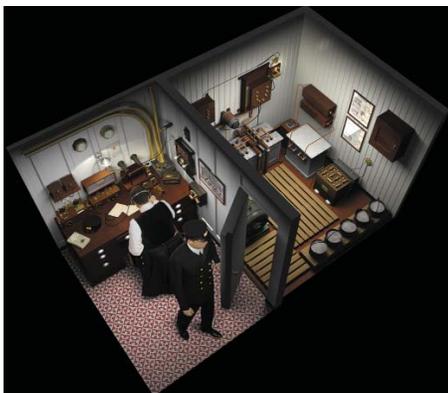
### April 11-13, 1912

The passengers and crew enjoyed a smooth, swift crossing. First class passengers marveled at the ship's many comforts and amenities, and they enjoyed the novelty of being able to send and receive countless wireless telegraph messages to and from their friends on shore.



### April 14, 1912, Mid-Afternoon

Jack Phillips and Harold Bride were on duty in the wireless room when they decoded a message from *Baltic*, another White Star Line ship. The message warned of "passing icebergs and a large quantity of field ice." Captain Edward Smith received the message and allegedly handed it, without comment, to Bruce Ismay. Ismay glanced at the note, and then stuffed it in his pocket.



## TITANIC'S LAST EVENING: COUNTDOWN TO A DISASTER

### April 14, Evening

The weather grew colder throughout the day. At 7:30 pm, it was 39° (F). By 8:30 it was close to freezing. The ocean temperature had dropped as well; by midnight it was 28°(F) (salty ocean water freezes at a lower temperature than fresh water). At 9:30, the senior operator in the wireless room received a message warning of a large field of ice, dead ahead. The operator was so busy transmitting messages for passengers that he never delivered the warning.



### April 14, Just Before 11:40 pm

A man in the crow's nest spotted a large, dark object, right in *Titanic's* path. He rang the bell in the crow's nest three times, and phoned the officer in the wheelhouse to warn him. Even so, at 11:40 pm, the starboard bow (right front side) of *Titanic* collided with the iceberg.

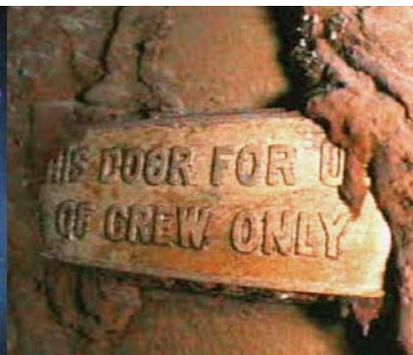
### April 15, 12:25 am

The ship was sinking fast. Captain Smith gave the order to load the lifeboats. Unfortunately, there were only enough lifeboats to carry 1,178 of the more than 2,200 people on board.



### April 15, 2:20 am

*Titanic*, still holding hundreds of people, sank beneath the waves. In all, 700 people were rescued, and more than 1,500 died.



Turn to page 12 for a Social Studies activity based on these pages.

# They Traveled on *Titanic*



**Molly Brown** – A newly wealthy socialite from Denver, Molly was a heroine throughout the sinking – urging people into lifeboats, taking up the oars herself, and sharing her warm furs with other lifeboat passengers. Most importantly, she fought back against a bullying ship officer who told the lifeboat passengers to take actions she thought would cause them all to die.

**Captain Edward Smith** – One of the most respected captains on the North Atlantic route. The maiden voyage of *Titanic* was to mark his retirement after a long and distinguished career. He perished in the wreck.



Re-enactments of the sinking of *Titanic* take place throughout *Ghosts of the Abyss*. Here, the terrifying early morning of April 15, 1912 is recreated.

**Thomas Andrews** – A Managing Director of Harland and Wolff and leader of the design teams for both *Titanic* and her sister ship *Olympic*, Andrews designed *Titanic* to carry and launch enough lifeboats to rescue everybody on board. But his good intention was spoiled. Somebody from the White Star Line (possibly



Managing Director J. Bruce Ismay), would not allow the necessary number of lifeboats on the ship because they would take up too much room on deck. When disaster struck, Andrews knew better than anybody else the likely fate of the ship he helped create. Yet he remained active throughout the sinking, bravely saving many lives, though not his own.

**Charles Lightoller** – Second Officer of the Deck, and the highest ranking officer to survive the disaster, Lightoller oversaw the loading of the lifeboats. He refused to join one of the boats himself. As *Titanic* finally went beneath the waves, Lightoller jumped into the ocean. He had started to swim clear of the ship when he was sucked against the grating of one of the large ventilator shafts and went down with the ship. But when the cold water encountered the hot boilers, he was blown back to the surface with a blast. Along with thirty other men, he spent the night clinging to an overturned collapsible lifeboat. Against all odds, he survived the night, and was the last *Titanic* survivor taken aboard the rescue ship *Carpathia*.

In hearings after the disaster, Lightoller talked about his actions in a very positive way. But other survivors said that some of his decisions slowed the loading of the lifeboats, leading to many unnecessary deaths.



**William Murdoch** – First Officer of the Deck, Murdoch was on the ship’s bridge at the time of the collision. Learning too late of the looming iceberg, he gave the orders to reverse the ship’s engines and to turn *Titanic* “hard a-starboard” (sharply to the right). But there was no way to avoid the disaster. In the terrible hours that followed, Murdoch distinguished himself by saving many lives through use of his own good judgment.



**J. Bruce Ismay** – Managing Director of the White Star Line, he was responsible for many of the decisions that resulted in the disaster. He allegedly demanded excessive use of speed under unsafe conditions, and refused, in the design phase, to allow the inclusion of enough lifeboats to guarantee the safe exit of all on board. He survived the disaster by boarding a lifeboat, leaving many others behind on deck.

**Harold Bride** – Marconi Officer and survivor of the disaster. According to Ken Marschall, “In the final moments of sinking, the ship’s power was becoming unstable. Harold Bride was trying to compensate for the loss of power. The pins and settings are still visible in the final settings that this man used.”



Officers on the port (left) side of the ship (particularly Charles Lightoller) interpreted Captain Smith’s command to load the lifeboats with women and children first to mean women and children *only*. This considerably slowed down the process of loading and lowering the boats, as women, refused to be separated from their husbands. But on the starboard (right) side, Murdoch allowed men, women and children to board, making it possible for more boats to be lowered faster (and generally more fully-loaded). As a result, William Murdoch saved many more lives than did Charles Lightoller. Unlike Lightoller, Murdoch did not survive to tell his own tale.



**Another re-enactment:**  
William Murdoch at *Titanic*’s wheel.

Turn to pages 12 – 13 for a Social Studies activity based on these pages.

# The Sinking of *Titanic*: The Historic Catastrophe

**Ken Marschall, *Titanic*'s leading "Visual Historian," and Don Lynch, Chief Historian of the Titanic Historical Society, played important advisory roles in James Cameron's 1997 film *Titanic*. They jumped at the chance to join the *Ghosts of the Abyss* team and actually dive to *Titanic* themselves.**



A painting by Ken Marschall from the new book *Ghosts of the Abyss: A Journey Into the Heart of the Titanic*, by Don Lynch with Ken Marschall.

## **Ken Marschall**

"It's been my world for so many decades," says Ken Marschall, who has made more than 100 paintings of *Titanic*. "I guess that's why people invite me along on these things, because I'm like a guide. I'll say, 'Okay, turn left here. We're just below the well deck on the starboard side.' I just know, because I've painted the ship so many times."

Ken knows the inside structure of *Titanic* better than anyone else alive. Although he did not train as an artist, his renderings are amazingly realistic. In fact, in high school, Ken submitted his first *Titanic* painting to his school's annual art show. The work was rejected, because the judges thought it looked too much like a photograph.

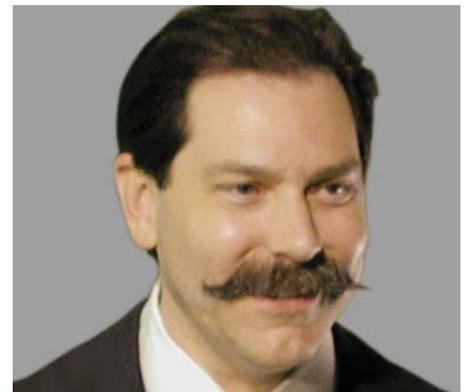
Fortunately, Ken has found many ways to put his distinctive talent to use. He has illustrated many books about *Titanic*, as well as books about the *Bismarck*, the *Hindenburg*, and the *Lusitania*. His more elaborate paintings can take up to 200 hours to complete.

When James Cameron made *Titanic* in 1997, he hired Ken to help the designers produce beautiful, realistic sets. In 2001, Cameron invited Ken to join the expedition for *Ghosts of the Abyss*. The filmmaker knew that Ken's knowledge of the ship would be invaluable.

## **A First-Hand Look**

During the *Ghosts of the Abyss* expedition, Ken went on four dives. He set the goals for each dive in which he took part, figuring out how to get to the rooms that needed to be explored, and planning the sequence of events. Ken says he was most excited by the discovery of the "Silent Room," where the wireless equipment

was stored. "The Silent Room had never been explored before, and it has all of the equipment in it that was used that night to summon help," says Ken. "You can still see the handles and the settings on these dials that the second Marconi operator, Harold Bride, manipulated that night, trying to fine-tune this wireless signal right to the end as the ship was sinking. So it's in effect the greatest time capsule that we have of that night."



Artist and *Titanic* expert Ken Marschall, here dressed as J. Bruce Ismay for a role in *Ghosts of the Abyss*

# that Shaped Two Modern Lives

## Don Lynch

After Don Lynch read Walter Lord's 1955 book *A Night to Remember* as a teenager, he joined the Titanic Historical Society and ordered all the back issues of their magazine. That was the start of what has evolved into a lifelong passion.

Over the years, Don has found many ways to pursue his interest. In high school, he wrote a term paper on the lifeboats that rescued 700 passengers. In college, he won a scholarship after writing a research paper on *Titanic*.

As Don read more about the story, he was struck by how little information there was about the survivors. As an adult, Don has spent much of his free time interviewing survivors. "The story of *Titanic* is what the witnesses saw," Don says. "If there had been no survivors, there wouldn't be a *Titanic* story. It would simply have been a ship that just sailed off and disappeared."



**Titanic historian Don Lynch here dressed as Thomas Andrews for a role in *Ghosts of the Abyss***

Don has spent years collecting the stories of the survivors. When he began his research in the 1970s, there were about a hundred survivors still living. Now there are just a handful. Don interviewed as many survivors as he could find who were willing to talk about their experiences. He has also researched many of the victims by interviewing their relatives and by reading old newspaper accounts.

In 1992, Don's years of research culminated in the publication of *Titanic: An Illustrated History*. The book is filled with photographs, personal

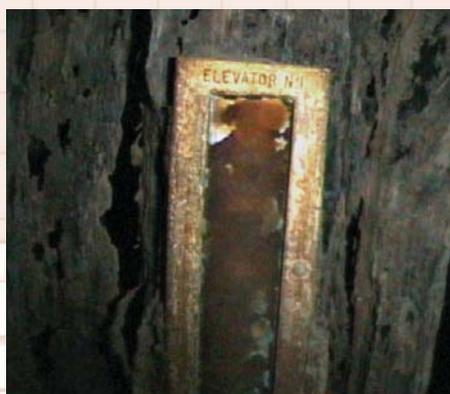
stories, and Ken Marschall's stunning paintings. [*Don Lynch and Ken Marschall have teamed up again on another book about this expedition. See the inside back cover of this Educator's Guide for more information.*]

During the filming of *Ghosts of the Abyss*, Don went on two submersible dives. This was his first chance to see *Titanic*, the ship he has researched for most of his life, with his own eyes.

The experience amazed him. "I've seen a lot of photos of the ship," he said. "All of a sudden, I realized I was looking at the D-deck portholes, and then on the next deck up I saw the windows for the suite that the Strauses (two first class passengers) were in. I was so surprised that I knew where I was. It was the ship. It was the specific rooms, and I actually knew what I was looking at. I was really pleased by that."



**Starboard (right-side) promenade deck of *Titanic***



**The Enunciator Panel for one of *Titanic*'s three first class elevators**



***Titanic* silverware on the ocean floor**

Turn to page 13 for Social Studies activities based on these pages.

# Educational Activities

## Introduction

Viewing *Ghosts of the Abyss* will stimulate the imaginations and interest of students in many ways. The revolutionary technology that made the expedition possible, including the submersibles, the ROVs, and the 3D cameras, will fascinate students as they realize that these devices make it possible to engage in a virtual visit to one of the most amazing destinations on earth: the *Titanic* wreck. Students may also be intrigued to approach the story of this disaster as modern-day detectives, as they see the ways in which this technology helps reconstruct an event from the past. The story of *Titanic* itself is a multi-layered history lesson, incorporating immigration, transportation, and the state of society at the beginning of the twentieth century.

The activities on the following pages are designed as companions to the film, and may be used either before or after going to the theater. The activities are designed for use by students in grades 5-8.

## Social Studies Activities

The material on pages 2-9 of this guide provides an introduction to the film, and a brief history of *Titanic*. This material may be photocopied and distributed to students as a reading activity. In addition, pages 12-13 feature a series of classroom activities that are keyed to the information presented on pages 2-9. These Social Studies activities are designed to help you expand the impact of the film in your classroom, as you encourage your students to stretch their imaginations and their writing abilities to put themselves in the positions of both the *Ghosts of the Abyss* explorers and those on board *Titanic* itself. “Imaginary Reflections” asks students to imagine a trip aboard one of the *Mir* submersibles. “Talk About It” helps students reflect on the impact of immigration and technology at the time of *Titanic*’s voyage. “*Titanic* Town Meeting” encourages students to learn more about some key individuals involved in the disaster. “Breaking Away on a Lifeline”

helps students reflect on the ways in which historical events can determine the course of a lifetime. Finally, “The Power of Observation” helps students better understand the tremendous amount of concentration and mental energy required to recreate and understand a complex event that took place in the past.

## Science Activities

Science activities are found on pages 14-23. Each activity in this section is designed with a page for educators’ use and a reproducible student page. With “Under Pressure,” science classes can explore properties of water pressure that must be considered in the design of deep-diving submersibles. “Finding the Way” introduces the concept of sonar, one of the most crucial tools in deep-ocean work. “The Amazing Invention Process” presents students with some approaches to consider when creating an invention, with the invention of the ROVs used in *Ghosts of the Abyss* as an example. “ROV Rescue” models the rescue mission performed by the ROV *Jake* on the ROV *Elwood* in the film. And “*Titanic*’s Twilight” profiles microbiologist Lori Johnston and describes the research she is undertaking with her mentor, Roy Cullimore, studying the disintegration of *Titanic* and other shipwrecks due to bacteria. A companion activity presents a chemical analogy to the bacterial process the ship is undergoing.



# Activities Conform to National Educational Standards

SOCIAL STUDIES ACTIVITIES

## NCSS Standards

ACTIVITY	STANDARD							
	Time, Continuity, and Change	People, Places and Environment	Individuals, Groups and Institutions	Power, Authority and Governance	Science, Technology and Governance	Global Connections	Civic Ideals and Society	Individual Development and Identity
Imaginary Reflections		●			●			
Talk About It		●	●		●	●		
<i>Titanic</i> Town Meeting		●	●	●	●		●	
Breaking Away on a Lifeline	●							●
The Power of Observation	●	●					●	

SCIENCE ACTIVITIES

## NSES Standards

ACTIVITY	STANDARD						
	Science as Inquiry	Physical Science	Life Science	Earth and Space Science	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
Under Pressure	●	●		●	●		
Finding the Way		●		●	●		●
The Amazing Invention Process	●	●			●		
ROV Rescue	●	●			●		
<i>Titanic's</i> Twilight	●	●	●				



# Social Studies Activities

*Ghosts of the Abyss* offers in-depth learning opportunities to enhance middle school Social Studies and Science curricula. The Social Studies activities on these pages are designed to accompany the film and the background material that appears on Pages 2-9 of this Educator's Guide. These activities align with national Social Studies standards. Science activities may be found on pages 14-23.

## Imaginary Reflections

(Accompanies pages 2-3)

**Objective:** Students will practice their skills as observers.

**Materials:** Pencils or pens, paper, chairs.

### Activity:

Underwater divers, whether they are scientists, artists, pilots, or simply observers, rely on their senses to make observations. For this activity, divide the class into groups of three. Have each group set up three chairs so they can form a triangle with their backs. This simulates the close quarters inside a submersible. Have each team member get a sheet of paper and pencil or pen and sit on one of the chairs. Students will then each pretend to be a member of a team going on a submersible dive.

On their papers, have them write their observations of the conditions in and around the sub at 8 am (when the dive begins), at 10 am (as the *Mir* reaches the *Titanic* wreck), at 1 pm (in the middle of *Titanic* observations), at 4 pm (as the *Mir* begins its ascent) and at 6 pm (when the *Mir* is about to be brought back up on *Keldysh*). One member of each team should pretend to be the pilot, and the other two the passengers.

Have students keep the following in mind:

- Use their senses to describe what they are seeing, hearing, feeling, and smelling.
- Describe their personal comfort, the air quality in the *Mir*, how the sub is operating, what the temperature is inside and outside the sub, what types of creatures they see.
- Describe what they imagine the other people on the submersible are doing.
- Try to describe in as great detail as their imaginations will allow what it would be like to spend twelve hours in such a small space, so far under water.

**Assessment:** Students should be able to write detailed descriptions of their reflections.

### Standards and Frameworks: Social Studies (NCSS)

- People, Places and Environments
- Science, Technology and Society

## Talk About It

(Accompanies pages 4-5)

**Objective:** Students will reflect on the larger meaning of an historic event.

**Materials:** None.

**Activity:** Review the material on pages 4-5 with your students, and lead a classroom discussion about one or both of the following topics.

1. Many of the passengers on *Titanic* were immigrants. Why would someone migrate from one country to another? Do your students know any immigrants? Discuss the immigrant experience.
2. The telegraph crew of *Titanic* might have gotten the warning about the iceberg in time if they were not overwhelmed with decoding personal messages. Who should decide the best use of a new technology?

**Assessment:** Students should be able to connect details about the sinking of *Titanic* to the contemporary world.

### Standards and Frameworks: Social Studies (NCSS)

- People, Places and Environments
- Science, Technology and Society
- Global Connections
- Civic Ideals and Practices
- Individuals, Groups and Institutions

## Titanic Town Meeting

(Accompanies pages 6-7)

**Objective:** Students will understand the complex interplay of individual decisions and group dynamics through a research project about the key players aboard *Titanic*.

**Materials:** Pencils or pens, paper.

**Activity:** The *Titanic* travelers who are described were among many who played important roles during the ship's sinking and in the aftermath of the disaster. Have students each choose one of these people, and conduct library or Internet research to learn more about him or her.

Have students think about what the word “hero” or “heroine” means to them. Does the person they researched fit their definition? Have students each write an essay about the person they researched and his or her role in the disaster. Some of these people were true heroes; others were not. Ask students to offer their opinions about how the people they researched behaved in the face of the terrible disaster.

As a class, have students come up with questions they might ask *Titanic* survivors Molly Brown, J. Bruce Ismay, or Harold Bride in a *Titanic* Court of Inquiry following the disaster. Some students might be willing to take on the roles of these individuals in a role-playing activity.

**Assessment:** Students will conduct independent research and participate in the “court of inquiry.”

**Standards and Frameworks: Social Studies (NCSS)**

- People, Places and Environment
- Power, Authority and Governance
- Civic Ideals and Practices
- Individuals, Groups and Institutions
- Science, Technology and Society

## Breaking Away on a Lifeline

**(Accompanies pages 8-9)**

**Objective:** Students will understand how key events shape life trajectories.

**Materials:** Pencils or pens, paper.

**Activity:** Just as the sinking of a ship or any tragic event can change the way society views the world, or the way individual survivors approach the rest of their lives, other events and experiences can have profound effects on “regular” people. For Ken Marschall, learning about the sinking of *Titanic* defined how he would spend his life.

Have students create “Y”-shaped lifelines for their own lives (or the life of somebody close to them). The lifeline should depict at least one major event or experience that shows a point of major change – a “shift.” Since the lifeline is shaped as a “Y,” students should be able to show what their life looks like and what goals they are aiming for on one fork, and what their life might turn out like if they choose the other path. As they build their “Y” lifelines, ask them to think about how reaching for a dream can make a life different than simply accepting what is handed to you.

Have students share their “Y” lifelines with the rest of the class. Talk with them about major milestones and the effect of single events on the course of a life.

**Assessment:** Students will create and present lifelines.

**Standards and Frameworks: Social Studies (NCSS)**

- Time, Continuity and Change
- Individual Development and Identity

## The Power of Observation

**(Accompanies pages 8-9)**

**Objective:** Students will investigate the complicated processes of observation through a role-play that challenges the notion of historical truth.

**Materials:** Pencils or pens, paper, video camera or tape recorder (optional).

**Activity:** Don Lynch has spent many years collecting and studying eyewitness accounts of the *Titanic* disaster. Sometimes these accounts contain details that conflict with one another. How do you know if a story is true? This activity will help students see how tricky it can be for eyewitnesses to reconstruct the details of an event. If possible, use a video camera or a tape recorder to make an accurate record of the event.

For this activity, two students should volunteer to act out a situation. The rest of the class will observe the situation. The volunteers should act out a scene that is somewhat complex and involves a lot of detail. It could involve a conversation or an argument between the two people, and some physical activity or props. If possible, videotape or tape record the encounter.

Without discussing what they saw with classmates, have half the class draw what they saw as accurately as possible, and half the class write as accurate a description as possible of what they saw. Suggest that the observers try to include at least ten details.

The class should share their observations, compare their findings, and then view or listen to the tape, if one was made. Were the students who drew what they remembered more or less accurate than the students who gave a written account?

**Assessment:** Students will draw or write their observations as accurately as possible. Students will reflect on their experiences as reporters.

**Standards and Frameworks: Social Studies (NCSS)**

- Time, Continuity and Change
- People, Places and Environments
- Civic Ideals and Practices

**Objective:** In this activity, students explore the relationship between water depth and water pressure, and discuss the impact of pressure on the design of deep-diving submersibles like the *Mirs*.

**Activity:** Students investigate the differences in blowing up a balloon in the air, in shallow water, and in deep water.

**Classroom Discussion:** Have students complete the simple experiment “Under Pressure.” Then, do the demonstration “Another Look at Water Pressure,” described below. Discuss the connection between students’ observations and the design of submersibles. Sample questions:

- What did your observations tell you about how pressure changes with the depth of the water?
- What is your evidence?

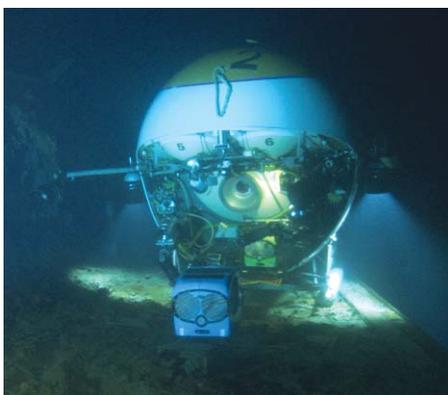
- What do you think this means for people who might want to explore the deep sea?
- How do you think water pressure might affect the design of a submersible? (Possible responses: it would need to withstand enormous water pressure by having thick walls; pressure on the inside would need to be maintained so people are comfortable.)

**Assessment:** Can students explain why increasing water pressure is important to deep-sea explorers?

**Standards and Frameworks: Science (NSES)**

- Science as Inquiry
- Physical Science
- Earth and Space Science
- Science and Technology

## SCIENCE BACKGROUND { The Weight of Water



The *Mirs*, like all deep-diving submersibles, are built with very strong, thick hulls to resist the enormous pressure of the deep ocean.

Though you may not be aware of it, the air around you has weight. To be exact, it weighs 14.7 pounds per square inch (1.03 kg per square centimeter). The weight creates an air pressure in all directions called “one atmosphere.” The pressure of water is also measured in atmospheres. Since water is so much heavier and denser than air, the weight and pressure increases quickly with depth. With each 33 feet (10 meters) of depth, another atmosphere is added. So a diver at 66 ft (20 m) under the surface is said to be diving at “two atmospheres.”

But breathing air under pressure from a scuba tank becomes more dangerous as the diver goes deeper, and divers don’t go much below 200 ft (60 m). To go deeper, people must travel in submersibles like the *Mirs*, with walls strong enough to resist the pressure of the surrounding seawater. Inside these submersibles, pressure is the same as on the surface – one atmosphere. To dive down 2.5 miles (4 kilometers) to the *Titanic* wreck, the *Mirs* have to be able to resist pressure greater than 5,800 pounds per square inch (412 kilograms per square centimeter).

## CLASSROOM DEMONSTRATION { Another Look At Water Pressure

Open the top of an empty 1-liter milk carton. Push one nail into the milk carton 3 in (about 8 cm) from the bottom of the carton. Push a second nail in the same side of the milk carton 5 in (about 13 cm) from the bottom. Push a third nail into the carton 7 in (about 18 cm) from the bottom. Place the milk carton on a plastic tub inside a rectangular cake pan. Fill a container with tap water. Then pour the water into the milk carton, filling it to the top. With help, pull all three nails out at the same time. Continue to pour water so that the milk carton stays full. As the water squirts out from the nail holes, have students watch to see how far each jet of water goes.



Name: \_\_\_\_\_

## Under Pressure



People need special equipment to make deep-sea dives. Submersibles are designed to make it possible to explore underwater life and shipwrecks far below the ocean's surface. It is important for a submersible to be able to sink, rise, and move under its own command. What other conditions must a submersible face when exploring the deep sea?

### You Will Need:

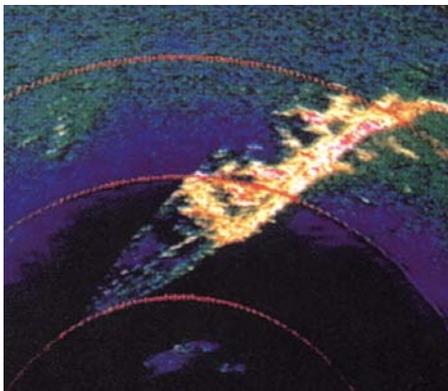
- One small balloon
- One plastic tube (about as long as your arm and about 3/8 inch (7 cm) in diameter)
- One small rubber band
- One tank or bucket of water

### Procedure:

1. Consider the following questions: Is it harder to blow up a balloon underwater or in the air? Is it harder to blow up a balloon in deep water or shallow water? Write your prediction on the other side of this paper.
2. Attach a small balloon to the end of a plastic tube.
3. Secure the balloon on the tube with the rubber band.
4. Fill the tank or bucket full of water.
5. Blow the balloon up above the water.
6. Let the air out of the balloon. Then blow the balloon up just below the surface of the water.
7. Finally, let the air out once more, then blow the balloon up at the bottom of the tank or bucket.

### What Did You Find Out? (Write your answers on the other side of this paper.)

1. Compare blowing the balloon up in the three different positions. If there were differences, describe them, and explain what caused the differences. If there were no differences, describe why you think there were no differences.
2. How does your experience relate to your predictions in Step 1 of the procedure above?



Locating an object on the ocean floor – even one as large as the *Titanic* wreck – requires patience, skill, and special equipment, such as the sonar device that made this image of *Titanic*.

**Objective:** Students simulate the use of sonar to create a seafloor profile.

**Activity:** Students learn the basic principles of sonar by conducting an experiential activity.

**Classroom Discussion:** Begin this activity by leading a discussion with students about tools and techniques scientists have developed to allow them to “see” beneath the ocean. Explain that sonar works by sending outgoing signals or sound pulses from a ship. The sounds travel to the seafloor and then are reflected back to the ship. The time required for the signals to make the trip are measured and the data are used to calculate the water depth. (See Science Background for additional information.) Then tell the class that they will play a game that models the way sonar can be used to map the seafloor.

**Assessment:** Students can describe the basic principles of sonar navigation.

**Standards and Frameworks: Science (NSES)**

- Physical Science
- Science and Technology
- Earth and space Science
- History and Nature of Science

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## SCIENCE BACKGROUND { “Seeing” the Seafloor with Sound

The *Titanic* wreck was discovered in 1985 by oceanographers from Woods Hole Oceanographic Institution, led by Robert Ballard, working with a group from the Institut Français de Recherche pour l’Exploitation de la Mer (I.F.R.E.M.E.R.), led by Jean Jarry. This momentous event could not have taken place without the extensive use of sonar technology.

Sonar devices, called echosounders, send sound pulses under the surface of the water. Underwater microphones called hydrophones receive sounds returning from the ocean floor. Computers convert the travel time data into a profile, or image, of the ocean floor.

The invention of sonar devices was critical to the development of submarines and submersibles, which, when underwater, rely on sonar to navigate and avoid other underwater objects.

On the 1985 expedition to find *Titanic*, the general latitude and longitude of the wreck was known, but there was a large area to explore. Oceanographers spent weeks patiently towing sonar devices back and forth over a relatively large swath of seafloor, to discover likely areas for closer inspection. This closer inspection was done by towed camera sleds that painstakingly “mowed the lawn” over a more defined area until, at last,

photographs of the wreck were successfully made. These devices then made it possible to create acoustic images of the seafloor.

Today, sonar devices are used for many purposes, including navigating around dangerous shoals and reefs in ocean shipping lanes, and conducting scientific investigations.



**Objective:** Students develop a concept and learn about the process of invention.

**Activity:** Students model the process used to develop *Jake* and *Elwood*.

**Classroom Discussion:** James Cameron worked with his brother Mike for two and a half years to build the ROVs *Jake* and *Elwood*. The team had to solve a series of difficult design problems. Review with your students the background material about the process of creating the ROVs. Then, using the student reproducible page “The Invention Process” on page 19, relate the steps to the process of inventing the ROVs.

Next, organize students into groups. Have each group develop a concept for a new product, or for improving an existing product. Have students “design” the product by creating a drawing or a model using various recycled materials.

Finally, have each group prepare a brief presentation describing : 1) the problem; 2) the design solution; and 3) how they would imagine implementing the design.

**Materials for Models:** A wide variety of craft materials would be appropriate, such as heavy cardboard tubes, wooden boxes, metal tubes, plastic tubes, scrap wood, metal scraps, glue, nails, tape, paint, string, hinges, etc.

**Assessment:** Students create a model for a product, describe the need for the product, and articulate its features.

**Standards and Frameworks: Science (NSES)**

- Science as Inquiry
- Physical Science
- Science and Technology

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## SCIENCE BACKGROUND { Creating a New Device

When James Cameron planned his return voyage to *Titanic*, he was determined to explore as much of the interior of the ship as possible. Cameron hoped to send the ROVs on jaunts of at least 2,000 feet (600 meters). He needed ROVs with much lighter, longer, and more flexible cable than was used on any ROV that existed at that time.

James Cameron took the problem to his engineer brother Mike, who has developed a number of different deep-sea imaging devices.

Here are the goals Mike and his team had to meet:

1. Navigate safely through tangled debris, hanging cables, confined spaces and around giant rusticles (icicle-shaped structures created by bacteria that eat elements in the ship’s metal).

2. Have propulsion that minimizes disturbance of the fine sediment.
3. Operate with a power system that optimizes battery usage.
4. Be able to exit the wreck at some location other than where it had entered, if necessary.

Mike and his team came up with a breakthrough solution. They invented a vehicle that could “pay out” its own thin fiber optic tether (about the diameter of fishing line), as a spider does when it spins a web. This tether would not need to be recovered. If the ROV got tangled, it would just pay out more tether.

To go from an inch-thick tether to a hair-thin one, the ROVs had to carry their own battery packs. This solution in turn created a new problem: a battery powerful enough to operate an ROV for the eight hours of a dive

would be heavy. To help the ROV remain neutrally buoyant (able to remain steady at a constant depth) would require so much syntactic foam (the floatation device used) that the ROV would become too large to fit comfortably into the imagined small spaces. This problem was partly solved by giving the syntactic foam several different tasks. By combining these functions, it was possible to keep the ROVs down to a manageable size.

Through trial and error, patience, and creativity, the engineers managed to overcome the obstacles and solve the problems placed before them. The result was *Jake* and *Elwood* – two devices that successfully brought back pictures of places unseen for more than ninety years.

# The Amazing Process of Invention



Mike Cameron checks an ROV before a dive.

James Cameron asked his brother Mike to create two ROVs for the *Ghosts of the Abyss* expedition. These vehicles had to have a number of special abilities. Though every invention is one-of-a-kind, many inventors follow a similar set of steps. Review the steps below. Think about how Mike Cameron and his team followed them to make *Jake* and *Elwood*. Then follow the same steps to make your own invention.

## The Invention Process

STEP N° 1 { **Identify problems for technological design. Identify a specific need.**

*Example:*

The *Ghosts of the Abyss* ROVs had to be able to:

- travel safely through the inside of a shipwreck;
- carry their own battery systems;
- exit the wreck at some location other than where they entered.

STEP N° 2 { **Make or create a proposal. Design a solution or product.**

*Example:* Mike Cameron and his team created a two-dimensional design, then built a three-dimensional prototype and tested it.

STEP N° 3 { **Organize materials and implement the design.**

*Example:* The actual ROVs were built and tested and retested a number of times in dive tanks.

STEP N° 4 { **Evaluate the completed design. Does the product meet the goals?**

*Example:* After each dive in the dive tanks, the ROVs were improved.

STEP N° 5 { **Use the invention and describe the process of design.**

*Example:* *Jake* and *Elwood* joined the *Ghosts of the Abyss* expedition.

**Objective:** Students construct a diving chamber and perform a rescue. Students describe how the concepts of water pressure, density and buoyancy are important in their rescue mission.

**Activity:** Students construct two simple submersibles to perform a rescue mission.

**Classroom Discussion:** Before beginning this activity with your students, review the concept of water pressure that was discussed along with the activity “Under Pressure.” Next, explain to your students the concepts of buoyancy and density described on this page. Explain to students that the following activity involves all three principles.

**Assessment:** After students complete their rescue missions, ask each one to write a brief explanation of the relationship between water pressure, density, and buoyancy.

Explanations could include some of the following information:

- The sunken submersible has a greater density than that of the rescue submersible.
- Squeezing the bottle increases pressure. Increased pressure forces more water into the rescue submersible.
- As the rescue submersible’s density increases, it becomes negatively buoyant and sinks.
- Careful, patient tilting and squeezing of the diving chamber eventually results in a rescue.
- The rescue submersible hooks the loop of the sunken submersible and rises to the surface as pressure is released from the diving chamber.

**Standards and Frameworks: Science (NSES)**

- Science as Inquiry
- Physical Science
- Science and Technology

SCIENCE BACKGROUND { **Buoyancy and Density**

As underwater explorers, James Cameron’s crew knew some basic facts about the deep ocean. Two concepts that they had to understand were buoyancy and density. The Greek mathematician Archimedes is believed to have first expressed the idea of buoyancy. He developed a mathematical proof demonstrating that an object partially or completely submerged into a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object.

A large ship is very heavy, but it floats because it displaces a large amount of water, thus creating a large buoyant force. Objects that float upwards towards the surface are positively buoyant. Objects that sink are negatively buoyant, and objects that remain steady at a constant state are neutrally buoyant.

By changing its mass, or the volume of space that it displaces, an object can be made to sink or float. Submersibles have ballast tanks that can be filled with air or water. When a ballast tank is filled with water, the

mass of the submersible increases, causing it to sink. Changing the content of the ballast tanks controls the submersible’s position in the water.

Density, a property of matter, is the mathematical relationship between mass and volume. It is expressed as a ratio, usually as  $D = m/v$  or density (D) equals mass (m) divided by volume (v).

Name: \_\_\_\_\_

## ROV Rescue

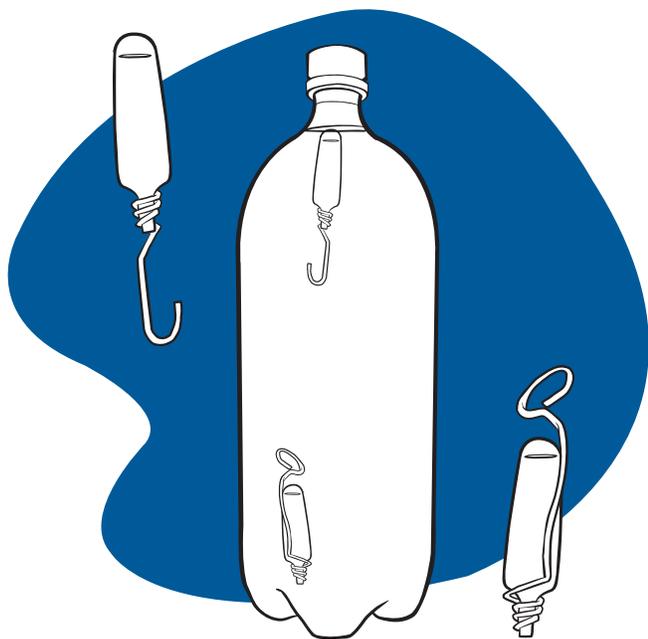
This activity lets you perform your own rescue of a sunken “ROV.” First, you will build two simple vehicles: one that floats and one that sinks. Then, you will rescue the sunken ROV inside a soda-bottle diving chamber.

### Your Group Will Need:

- 2 plastic eyedroppers
- 1 clear plastic 1-liter soda bottle with cap (label removed)
- Scissors
- Tap water
- 2 15-cm lengths of thin wire
- 1 metric ruler
- 1 250-ml beaker
- Small ball of clay (optional)

### Procedure:

1. Use the picture below as a guide when building the rescue ROV. Wrap one piece of wire tightly around 1 cm of an eyedropper nearest the cap. Near the bottom of the tube, use wire to form a hook. Then, cut off the unused wire and the unwrapped part of the eyedropper tube.



2. Build a second ROV like the first, but form a loop at the top of the tube.

3. Fill the beaker with tap water. Squeeze both eyedroppers under the water’s surface to fill the ROVs with water.
4. Fill the soda bottle to the top with water. Put both ROVs into the soda bottle. The rescue ROV with the hook should float. The looped ROV that must be rescued should slowly sink to the bottom and stay there. You may need to adjust the ROVs by:
  - increasing the air in the rescue ROV;
  - cutting off some wire to help the rescue ROV float;
  - increasing the water in the sunken ROV;
  - adding clay to the lower end of the sunken ROV to make it sink.
5. Rescue the sunken ROV by lowering the rescue ROV, hooking them together, and bringing them both up to the surface. (Hint: to lower the rescue ROV, squeeze the bottle.)
6. After you have successfully rescued the sunken ROV and brought it to the surface, practice the mission several times. Write a brief explanation of how you rescued the ROV. Explain the scientific concepts that were involved.



**Objective:** Students learn about rusticles, bacterial formations that are gradually eating away the steel hull of *Titanic*, and about the scientists who study them.

**Activity:** Students grow rusticles on a steel plate.

**Class Discussion:** Review with students the information about microbiologist Lori Johnston, shown below. Point out that although Lori studies biological formation of rust on metal, the classroom activity will demonstrate a chemical, not a biological process. Then prepare an 8% salt solution by mixing 8 grams of sea salt in 100 ml of water.

**Assessment:** Students should be able to predict the outcome of their experiment, and be able to state the reasons for that outcome.

**Standards and Frameworks: Science (NSES)**

- Science as Inquiry
- Physical Science
- Life Science

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SCIENCE BACKGROUND { **Bacteria Take Over**

As the *Titanic* wreck slowly disintegrates, it is actually turning into a gigantic colony of living organisms. “*Titanic* has more life on it now than when it was on the surface,” says Lori Johnston, a microbiologist who was part of the *Ghosts of the Abyss* team. “The life is the bacteria that’s found on the ship, which is in the form of these rust-colored ‘icicles,’ called rusticles.”

Rusticles are formed by bacteria, which remove elements such as iron, manganese, sulfur and other elements from the steel. The bacteria store the removed elements, thus creating rusticles. In the process of mining the elements, the rusticles cause the erosion of the wreck.

Lori is the research assistant to Dr. Roy Cullimore, who was the first biologist to perform experiments on the ship. In 1996, Roy placed four test platforms on the ship. When Lori dove in 2001, she asked James Cameron to shoot video of the platforms. That way she could measure the rate of rusticle growth. “Through the imagery Jim Cameron brought us back with the ROVs, there are new rusticles that we’d never seen before and slime clouds – types of bacteria that are floating in the water that hold structure and yet, they’re translucent,” said Lori.

*Titanic* is almost completely covered, inside and outside, with rusticles. The largest ones are six feet long (1.8 m) and six inches (15.2) cm in diameter.

As the rusticles grow larger, the ship is growing more fragile. One reason these bacteria thrive is that in the deep North Atlantic, they have no competitors. “On shipwrecks that occur at depths where there’s a certain amount of sunlight, where life is very vibrant, there are rusticles, but the rusticles will get out-competed by corals, algae, and other types of organisms,” said Lori. “At *Titanic*, there’s nothing that can out-compete the rusticles, so these bacteria have become the dominant organism on the ship.”

# Titanic's Twilight



Titanic in 1986



Titanic in 1996



Titanic in 2012



Titanic in 2112

The *Titanic* wreck is covered with rusticles – rust-colored growths shaped like icicles. These formations are actually bacteria that eat elements out of the hull of the ship. Microbiologists, scientists who study the smallest forms of life, are investigating the rusticles. Research shows that rusticles are made up of elements such as manganese, iron, and sulfur. The rusticles draw out these elements from the metal, and are literally eating the shipwreck.

Says Lori Johnston, a microbiologist who studies rusticles, and who was part of the *Ghosts of the Abyss* expedition, “*Titanic* will eventually be an iron-ore deposit on the bottom of the ocean.”

Lori and other researchers hope their work will help them predict how long it will be until *Titanic* is completely eroded. The two pictures on the left above show what the *Titanic* wreck might have looked like based on research from expeditions in 1986 and 1996. The two right-hand pictures predict what it might look like in 2012 and 2112.

There are other uses for this information, too. For example, the engineers who design platforms used by deep-sea oil workers are interested to learn more about how rusticles affect the strength of the platforms they design.

## Making Rusticles

In this experiment, you will observe rust growing on steel. By placing a steel plate or bolt inside a glass tank filled with salt water, you will produce growths that are similar to those that cover *Titanic*. But these growths will be created by a chemical process, while the rusticles on *Titanic* are created by a biological process.

### You Will Need:

- Several large glass jars (one for every four or five students)
- Salt water solution (made by the teacher)
- Steel plates or steel bolts

### Procedure:

1. Fill a jar or beaker with the salt water solution.
2. Place a steel plate or bolt in the beaker.
3. Observe the steel plate over a period of at least two weeks.

### What Did You Find Out? (Write your answers on the other side of this paper.)

How long did it take for the rusticles to grow? What did they look like? What other changes took place in the glass jars?

# Vocabulary

**acoustic** adj. – About or related to sound.

**allegedly** adv. – When someone accuses or supposes someone else has done something wrong but has insufficient proof to assign guilt.

**amenities** n. – Items that add to a person's social and physical comfort or status.

**ballast** n. – Material added to a ship to make it less positively buoyant and to add stability. In the case of a submersible, ballast tanks function by taking on or releasing water to help the vehicle sink, rise, or remain at a constant depth.

**bow** n. – The front portion of a ship.

**buoyancy** n. – The degree to which an object is able to remain afloat in a liquid

- Positive buoyancy – when an object can float.
- Neutral buoyancy – when an object neither floats nor sinks, remaining right at the water line or at a constant depth, equalized with its surroundings.
- Negative buoyancy – when an object sinks.

**crow's nest** n. – The high perch on a ship from which a crew member can view items far in the distance without obstruction.

**debris** n. – Remnants that are left over after an accident or violent change.

**density** n. – The ratio of mass to volume in matter, or how much mass is packed into a certain three-dimensional space.

**echosounder** n. – A device that bounces sound waves off of other objects to determine their distance.

**fiber optics** n. – Ultra-thin tubes, usually made of synthetic material that carry light impulses back and forth between two objects. In the case of the ROVs,

the fiber-optic cables carry commands to the ROVs and camera images back to the submersible.

**heroine** n. – A female hero.

**hydrophone** n. – An underwater microphone that can receive sounds from the ocean floor.

**latitude** n. – The measurement of a location on the globe telling how far north or south of the Equator it lies. Latitude lines run around the globe parallel to the Equator, ending as points on each pole.

**longitude** n. – The measurement of a location on the globe telling how far east or west of the Prime Meridian it lies. Longitude lines run north-south, meeting each other at each pole.

**Marconi** p.n. – Name given to the wireless telegraph device invented in 1896 by Guglielmo Marconi. Its use was a novelty and luxury aboard *Titanic*.

**microbiology** n. – The branch of science that deals with the study of life that is extremely small, often too small to see with the naked eye.

**oceanography** n. – The branch of science concerned with studying all aspects of oceans.

**optimize** v. – To make something as efficient and as perfect as possible.

**perish** v. – To die.

**port** n. – The left-hand side of a ship when facing forward toward the bow.

**propulsion** n. – A force that pushes an object into motion.

**prototype** n. – A test version of something new meant to work out any unforeseen problems before full production occurs.

**rendering** n. – A representation of something, often through a drawing or a painting.

**ROV** n. – Remotely Operated Vehicles are underwater exploration devices that are connected to a power source by a cord or tether.

**rusticle** n. – Rust-colored growths shaped like icicles that eat metal, especially the hull of a shipwreck deep in the ocean where there is no other competition.

**scuba** n. – Stands for Self-Contained Underwater Breathing Apparatus.

**socialite** n. – A person who takes part in highly visible social or charitable events.

**steerage** n. – The area in the lower decks of a ship where the least wealthy people and packed belongings were transported.

**sonar** n. – Stands for SOund Navigation and Ranging – a system that bounces sound waves off the sea floor to detect and locate submerged objects or measure the distance to the floor of a body of water.

**stern** n. – The rear portion of a ship.

**starboard** n. – The right-hand side of a ship when facing forward toward the bow.

**submersible** n. – An underwater vehicle capable of sinking and rising under its own power.

**telegraph** n. – A messaging system invented in the 1800s that transmits electromagnetic impulses back and forth between distant points.

**tether** n. – A cord that attaches one object to another.

# Resources

## Books about *Titanic*:

Ballard, Robert D. *The Discovery of the Titanic*. New York: Warner Books, 1995. In 1985 and 1986 Ballard led expeditions that discovered and first explored the wreck. This book tells their story through text and photographs.

Bryceson, Dave. *The Titanic Disaster*. New York: W. W. Norton & Company, 1997. A collection of newspaper articles printed in the days following the *Titanic* disaster, this book offers insight into the slow unfolding of the story.

Lord, Walter. *A Night to Remember*. New York: Bantam Books, 1997. This classic, originally published in 1955, recounts the events of the night *Titanic* went down.

Lord, Walter. *The Night Lives On*. New York: William Morrow and Co., 1986. Lord revisits some questions that were left unanswered for many years. For example: Was *Titanic* well constructed? Why were there so few lifeboats? Was the captain able to handle the boat?

Lynch, Don. *Titanic: An Illustrated History*. New York: Hyperion, 1992. Lynch, Chief Historian for the Titanic Historical Society, provides a comprehensive look at the events that led up to the sinking of the famous ocean liner. The book abounds with stories and photographs of many of the ship's passengers. Ken Marschall's paintings complement the text.

## *Titanic* Web Sites:

[www.encyclopedia-titanica.org](http://www.encyclopedia-titanica.org)

This site is a resource for new research on *Titanic*. It contains more than 2,100 biographies of passengers, research articles related to the history of the ship and to current exploration of the wreck.

[www.titanic1.org](http://www.titanic1.org)

This is the Web site for The Titanic Historical Society, Inc. the world's largest *Titanic* organization. It was established in 1963. The THS is dedicated to preserving *Titanic*'s history. Their Web site is filled with information about the White Star Line, *Titanic* passengers, and current events devoted to commemorating significant dates. For more information write to: PO Box 51053, 208 Main Street, Indian Orchard, MA 01151-0053, Tel: (413) 543-4770.

## Books about Underwater Exploration:

Gaines, Richard. *The Explorers of the Undersea World*. New York: Chelsea House Publishers, 1994. A history of underwater exploration from the early 1800s through modern times.

Haslam, Andrew & Barbara Taylor. *Oceans*. Chicago: World Book Inc., 1997. With background information on studying oceans, this book also contains numerous experiments suitable for the classroom.

Kovacs, Deborah. *Dive to the Deep Ocean*. Austin, Texas: Steck-Vaughn Company, 2000. This book takes a historical look at deep-sea exploration, beginning with the earliest pioneers and following the evolution of modern ocean research.

Markle, Sandra. *Pioneering Ocean Depths*. New York: Atheneum Books for Young Readers, 1995. An examination of ocean-related topics, including deep-sea creatures, ROVs, and submersibles.

## Books for Educators about Underwater Exploration:

Day, Trevor. *Oceans*. New York: Facts On File, Inc., 1999. In an encyclopedic presentation, this book examines topics ranging from the chemistry of the world's oceans to the economic resources and health of the oceans.

Prager, Ellen J. with Sylvia A. Earle. *The Oceans*. New York: McGraw-Hill, 2000. A comprehensive look at the world's oceans, past, present, and future.

Rice, Tony. *Deep Ocean*. Washington, D.C: Smithsonian Institution Press, 2000. An in-depth examination of the various forms of life that dwell throughout the ocean. Beautiful color photographs complement the text.

## *Ghosts of the Abyss* Companion Books:

Lynch, Don, with Ken Marschall. *Ghosts of the Abyss: A Journey into the Heart of the Titanic*. Cambridge: Da Capo Press/Madison Press, 2003. *Titanic* historian Don Lynch and illustrator Ken Marschall tell the story of the expedition that took place in the summer of 2001. The text, photographs, and drawings combine to create a captivating look at the journey that resulted in James Cameron's documentary.

Majoor, Mireille. *Titanic: Ghosts of the Abyss*. New York: Hyperion/Madison Press, 2003. This 3D book recreates many of the amazing scenes shown in the film.

Visit [www.ghostsoftheabyss.com](http://www.ghostsoftheabyss.com) for more information and interactive activities on *Ghosts of the Abyss*.

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