

Welcome...

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EXIT

The Electronic Module

Course : **Basic Science**

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Introduction

Introduction

What is Science

How Science Work

Science, Society &
Technology

Evaluation

- **Course Description**

This course will examine what is science, how science works, and how the influence of science on technological development and social life



To Listen





Standard of Competences

Introduction

What is Science

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- Understanding the definition of science from many perspective :
 - Science as way of Thinking,
 - Science as way of investigating, and
 - science as body of knowledge,
- Applying scientific method to solve various problems in everyday life, and
- Understand the interactions between science, technology and society



To Listen





Where to begin? start our investigation:

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- **What is science?** Find out what makes science
- **How does it work?** Probe the nuts and bolt of the Process Of Science
- **Why is it important?** Learn how science affect our life everyday and how you can apply an understanding of the nature of science in our everyday life.



To Listen





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What Is Science?



To Listen



What is science?

Myths of Science Quiz True or False?

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- Science is a system of beliefs.
- Most Scientist are men because males are better at scientific thinking
- Scientists really heavily on imagination to carry out their work
- Scientists are totally objective in their work.
- The Scientific method is the accepted guide for conducting research.



To Listen



What is science?

Myths of Science Quiz True or False?

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- Experiments are carried out to prove cause-and-effect relationships.
- All scientific ideas are discovered and tested by controlled experiments.
- A hypothesis is an educated guess.
- When a theory has been supported by great deal of scientific evidence, it becomes a law.
- Scientific idea are tentative and can be modified or disproved.



To Listen



What is science?

What is science?

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Understanding Science: An overview

- To understand what science is, just look around you. What do you see?



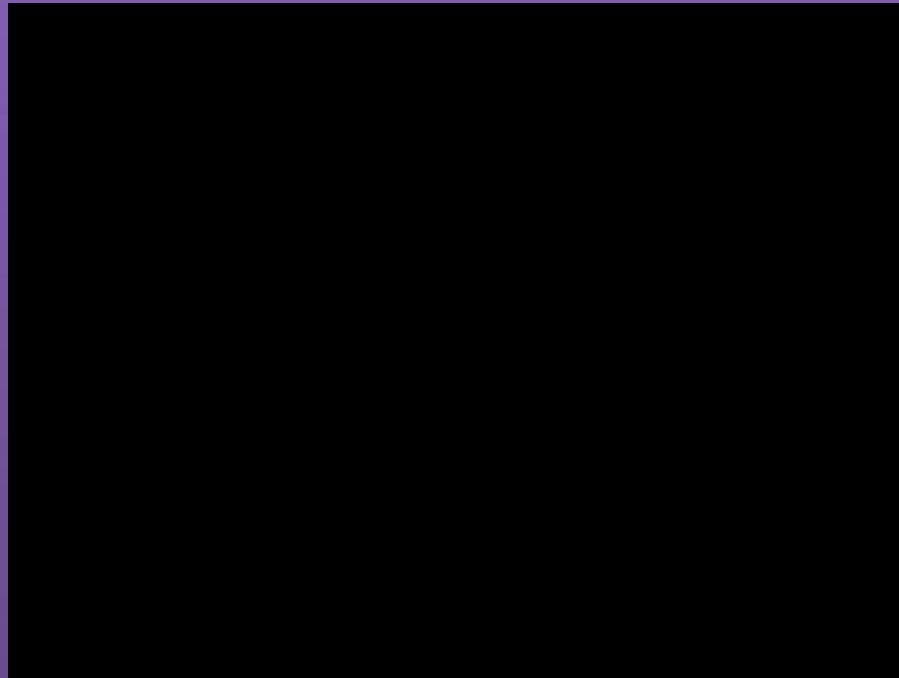
To Listen



What is science?

What is science?

- Science is, in one sense, our knowledge of all the *stuff* in the universe: from the tiniest subatomic particles in a single atom to the nuclear reactions that formed the immense ball of gas that is our sun



Introduction

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To Listen



What is science?

What is science?

- science is also a reliable process by which we *learn* about all that stuff in the universe

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To Listen



What is science?

The most important characteristics of science

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- Science focuses exclusively on the natural world, and does not deal with supernatural explanations.
- Science is a way of learning about what is in the natural world, how the natural world works, and how the natural world got to be the way it is.
- Scientists work in many different ways, but all science relies on testing ideas by figuring out what expectations are generated by an idea and making observations to find out whether those expectations hold true.



To Listen



What is science?

The most important characteristics of science

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- Accepted scientific ideas are reliable because they have been subjected to rigorous testing, but as new evidence is acquired and new perspectives emerge these ideas can be revised.
- Science is a community endeavor. It relies on a system of checks and balances, which helps ensure that science moves in the direction of greater accuracy and understanding.



To Listen



What is science?

Toward
a Definition of Science:

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Science is broad-based human enterprise that is defined differently depending on the individual

- A layperson might define science as body of scientific information.
- A scientist might view it as a set of procedures by which hypotheses are generated and tested.
- A philosopher might regard science as way of questioning the truthfulness of what we know.



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What is science?

Toward a Definition of Science:

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- Prospective science teachers might put forth the following phrases when asked for definition of science:
 - To Discover nature
 - Using Scientific Method
 - A process of finding out
 - A study of the universe
 - Organizing facts into theories
 - A method of discovery
 - A body of organized knowledge
 - Problem solving
 - A Search for Truth



To Listen



What is science?

Toward
a Definition of Science:

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The National Academy of Sciences

- Science is a particular way of knowing about the world. In science, explanations are limited to those based on observations and experiments that can be substantiated by other scientists. Explanations that cannot be based on empirical evidence are not part of science



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What is science?

Toward
a Definition of Science:

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- All of those definitions reflect some aspect of science, but none of them provides a full picture because science has so many facets:
 - Science as a way of thinking
 - Science as way of investigating
 - Science as Body of Knowledge



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What is science?

Science
as a way of thinking

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- Beliefs
- Curiosity
- Imagination
- Reasoning
- Cause-and-Effect Relationships
- Self-Examination and Skepticism
- Objectivity and Open-Mindedness



To Listen



What is science?

Science
as a way of investigating

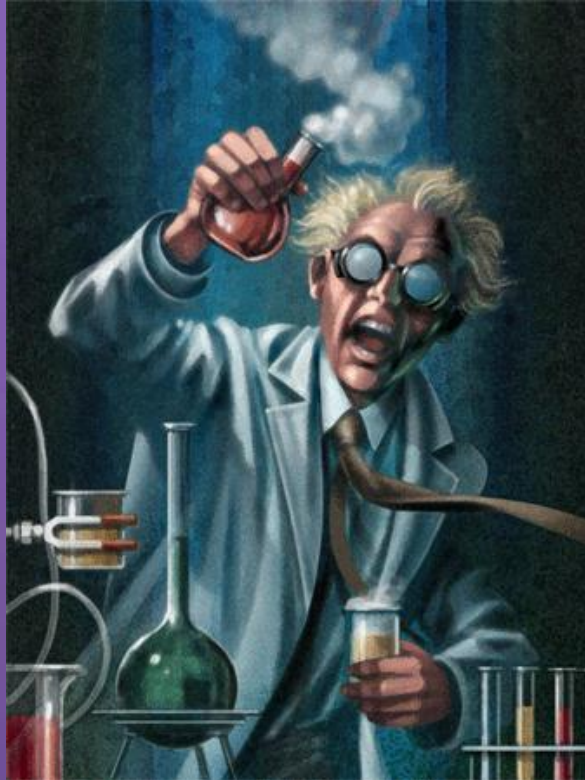
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- Observing
- Collecting data
- Developing a hypothesis
- Experimenting
- Concluding



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What is science?

Science
as a body of knowledge

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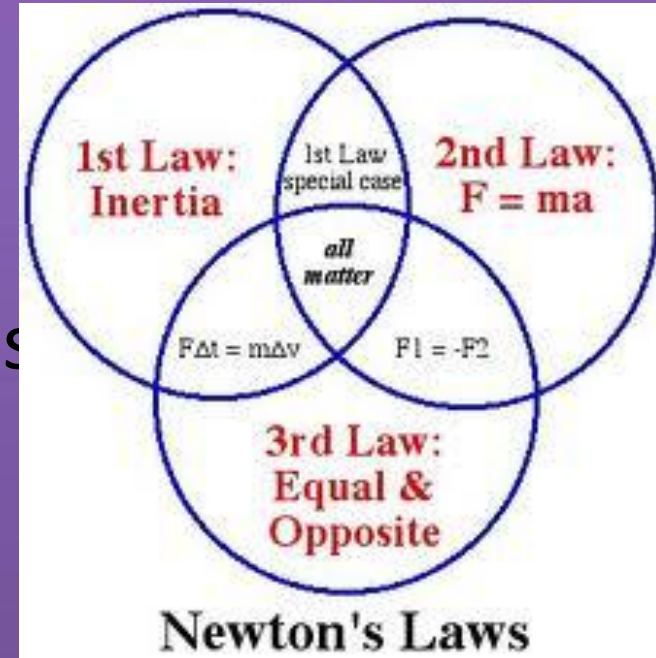
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- Fact
- Concepts
- Laws and Principles
- Theories



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What is science?

So what,
exactly, *is* science?

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Well, science turns out to be difficult to define precisely

- The problem is that the term "*science*" applies to a remarkably broad set of human endeavors, from developing lasers, to analyzing the factors that affect human decision-making.
- To get a grasp on what science is, we'll look at a checklist that summarizes key **characteristics of science** and compare it to a prototypical case of science in action: Ernest Rutherford's investigation into the structure of the atom.



To Listen





Watching Video

Introduction

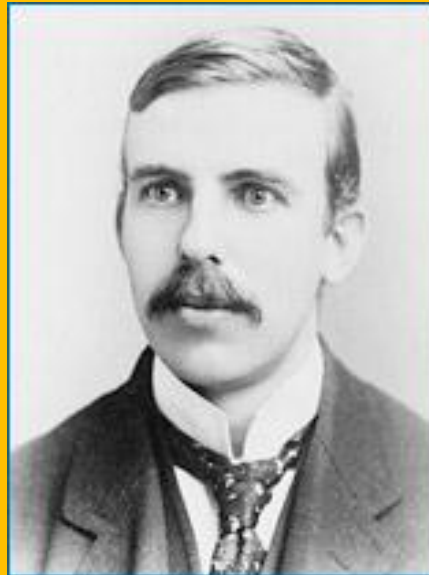
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A SCIENCE PROTOTYPE: RUTHERFORD AND THE ATOM



Vs

Science checklist: How scientific is it?

- Focuses on the natural world
- Aims to explain the natural world
- Uses testable ideas
- Relies on evidence
- Involves the scientific community
- Leads to ongoing research
- Benefits from scientific behavior

Click The Picture to Watching movie



To Listen



What is science?

A science checklist

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1. Focuses on the natural world

- Science asks questions about the natural world, Science studies the natural world.
- This includes the components of the physical universe around us like atoms, plants, ecosystems, people, societies and galaxies, as well as the natural forces at work on those things.



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What is science?

A Science Prototype:

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RUTHERFORD AND THE ATOM

- In the early 1900s, Ernest Rutherford studied (among other things) the organization of the atom — the fundamental particle of the natural world. Though atoms cannot be seen with the naked eyes, they can be studied with the tools of science since they are part of the natural world.



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What is science?

A science checklist

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2. Science aims to explain and understand the natural world

- Science as a collective institution aims to produce more and more accurate natural explanations of how the natural world works, what its components are, and how the world got to be the way it is now.
- Classically, science's main goal has been building knowledge and understanding, regardless of its potential applications



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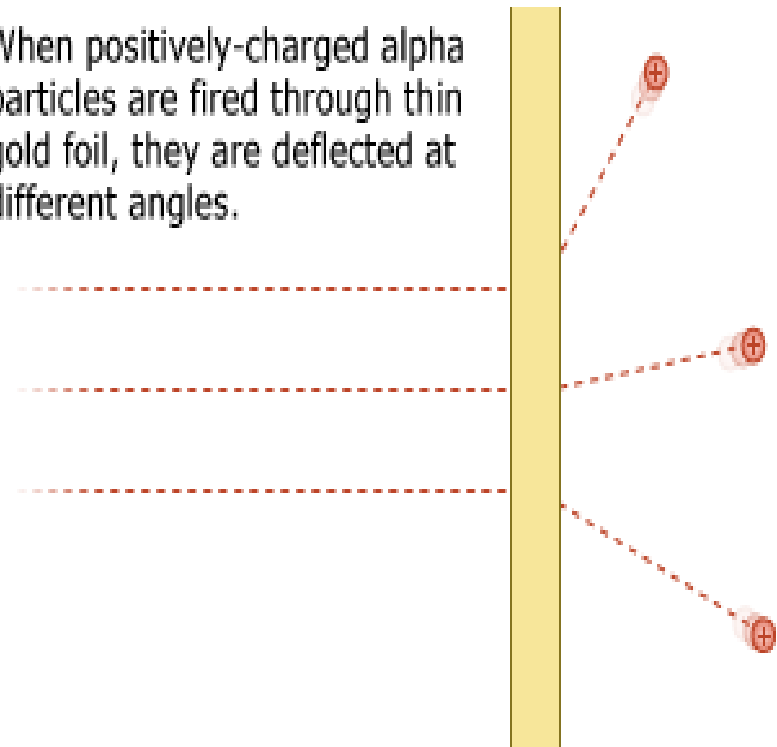


What is science?

A Science Prototype:

- Ernest Rutherford's investigations were aimed at understanding the natural world: the atom. He investigated this world using alpha particles, which are helium atoms stripped of their electrons.
- Rutherford had found that when a beam of these tiny, positively-charged alpha particles is fired through gold foil, the particles don't stay on their beeline course, but are deflected (or "scattered") at different angles.

When positively-charged alpha particles are fired through thin gold foil, they are deflected at different angles.



To Listen



What is science?

A science checklist

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3. Science works with testable ideas

- A scientific idea may require a lot of reasoning to work out an appropriate test, may be difficult to test, may require the development of new technological tools to test, or may require one to make independently testable assumptions to test — but to be scientific, an idea *must* be testable, somehow, somehow.



To Listen

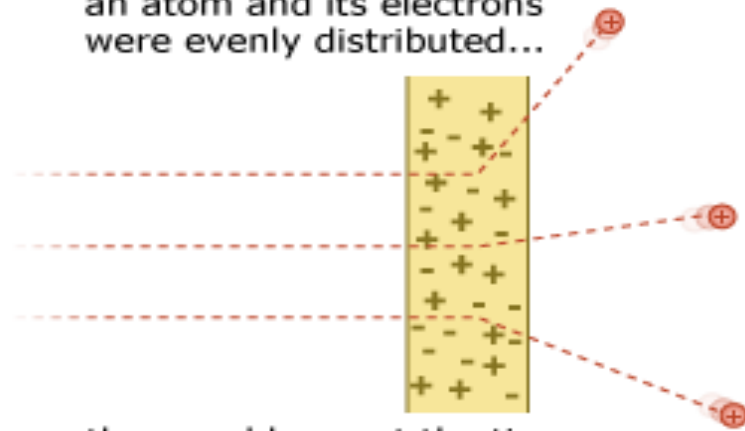


What is science?

- Before 1910, Ernest Rutherford and many other scientists had the idea that the positive charge and the mass of an atom were evenly distributed throughout the whole atom, with electrons scattered throughout.
- The idea that atoms are arranged in this way can be tested by firing an alpha particle beam through a piece of gold foil.
- If the idea were correct, then the positive mass in the gold foil would be relatively diffuse (the loosely packed snow) and would allow the alpha particles to pass through the foil with only minor scattering.

A Science Prototype:

If the positive mass of an atom and its electrons were evenly distributed...



...then you'd expect the tiny alpha particles to easily pass through the gold foil with little deflection.

To Listen



What is science?

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4. Science relies on evidence

- the acceptance or rejection of a scientific idea depends upon the evidence relevant to it — not upon dogma, popular opinion, or tradition.
- In science, ideas that are not supported by evidence are ultimately rejected.
- Ideas that are protected from testing or are only allowed to be tested by one group with a vested interest in the outcome are not a part of good science.



To Listen



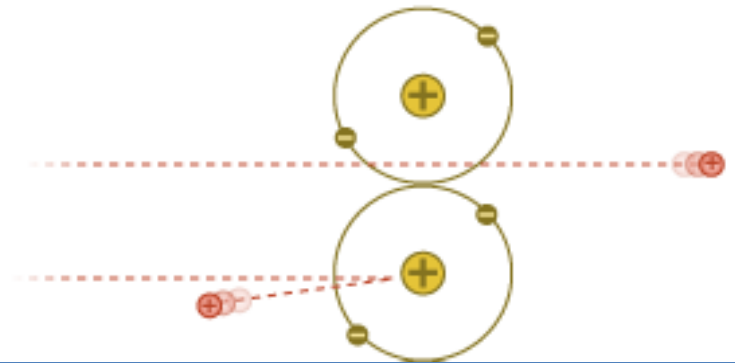
What is science?

- Ernest Rutherford's lab tested the idea that an atom's positive mass is spread out diffusely by firing an alpha particle beam through a piece of gold foil, but the evidence resulting from that experiment was a complete surprise.
- Most of the alpha particles passed through the gold foil without changing direction much as expected, but some of the alpha particles came bouncing back in the opposite direction, as though they had struck something dense and solid in the gold foil.

To Listen 

A Science Prototype:

The observed deflection of alpha particles shows that atoms have their positive charge concentrated in a dense mass.



From this evidence, Rutherford concluded that an atom is mostly empty space and that its positive charge is concentrated in a dense mass at its core, forming a nucleus

What is science?

A science checklist

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5. Science is embedded in the scientific community

- The progress of science depends on interactions within the scientific community — that is, the community of people and organizations that generate scientific ideas, test those ideas, publish scientific journals, organize conferences, train scientists, distribute research funds, etc.
- It is also responsible for the further testing and scrutiny of ideas and for performing checks and balances on the work of community members.



To Listen

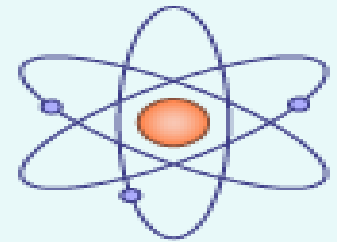


What is science?

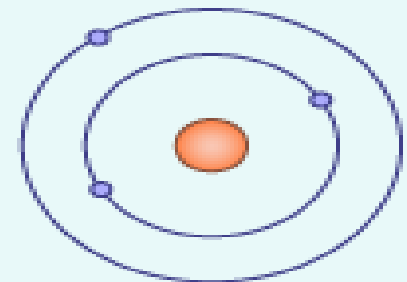
A Science Prototype:

- Though Ernest Rutherford came up with the idea that atoms have positively charged nuclei, the research that led to this idea was a collaborative effort: Rutherford was assisted by Hans Geiger, and the critical alpha-scattering experiment was actually carried out by Ernest Marsden, an undergraduate student working in Rutherford's lab.
- Niels Bohr noticed a problem with Rutherford's idea: there was nothing keeping the orbiting electrons from spiraling into the nucleus of the atom, causing the whole thing to collapse! Bohr modified Rutherford's basic model by proposing that electrons had set energy levels, which helped solve the problem and earned Bohr a Nobel Prize

Rutherford's model of the atom



Bohr's model of the atom



To Listen



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A science checklist

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6. Scientific ideas lead to ongoing research

- Most typically in science, answering one question inspires deeper and more detailed questions for further research.
- in a science, the more we know, the more we know what we don't yet know



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What is science?

A Science Prototype:

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- Niels Bohr built upon Ernest Rutherford's work to develop the model of the atom most commonly portrayed in textbooks: a nucleus orbited by electrons at different levels.
- Despite the new questions it raised (e.g., how do orbiting electrons avoid violating the rules of electricity and magnetism when they don't spiral into the nucleus?), this model was powerful



To Listen



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7. Participants in science behave scientifically

- Pay attention to what other people have already done
- Expose your ideas to testing
- Assimilate the evidence.
- Openly communicate ideas and tests to others.
- Play fair: Act with scientific integrity.



To Listen



What is science?

Characteristics of Science

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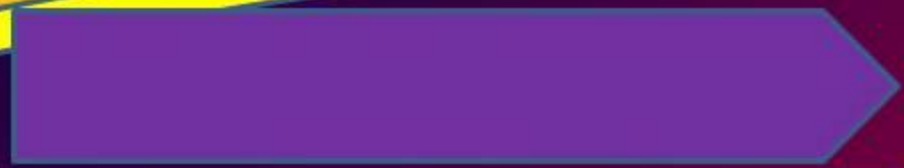
Science checklist: How scientific is it?

- Focuses on the natural world
- Aims to explain the natural world
- Uses testable ideas
- Relies on evidence
- Involves the scientific community
- Leads to ongoing research
- Benefits from scientific behavior



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How does Science Work?





How Does Science Work?

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- The Scientific Method is traditionally presented in the first chapter of science textbooks as a simple recipe for performing scientific investigations.





How Does Science Work?

Traditional “Scientific Methods”

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Scientific Method (1 serving)

1. Ask a question.
2. Formulate a hypothesis.
3. Perform experiment.
4. Collect data.
5. Draw conclusions.

Bake until thoroughly cooked.

Garnish with additional observations.

Too simple!





How Does Science Work?

The Limitation of “Traditional Scientific Method”

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- The linear, stepwise representation of the process of science is simplified, but it does get at least one thing right. It captures the core logic of science: testing ideas with evidence.
- However, this version of the scientific method is so simplified and rigid that it fails to accurately portray how real science works.





How Does Science Work?

Implications of Using “Traditional Scientific Method”

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- 1. The simplified, linear scientific method implies that scientific studies follow an unvarying, linear recipe.**
 - **But in reality**, in their work, scientists engage in many different activities in many different sequences. Scientific investigations often involve repeating the same steps many times to account for new information and ideas.





How Does Science Work?

Implications of Using “Traditional Scientific Method”

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2. The simplified, linear scientific method implies that science is done by individual scientists working through these steps in isolation.

- **But in reality**, science depends on interactions within the scientific community. Different parts of the process of science may be carried out by different people at different times.





How Does Science Work?

Implications of Using “Traditional Scientific Method”

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3. The simplified, linear scientific method implies that science has little room for creativity.

- **But in reality**, the process of science is exciting, dynamic, and unpredictable. Science relies on creative people thinking outside the box!





How Does Science Work?

Implications of Using “Traditional Scientific Method”

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4. The simplified, linear scientific method implies that science concludes.

- **But in reality**, scientific conclusions are always revisable if warranted by the evidence. Scientific investigations are often ongoing, raising new questions even as old ones are answered.





How Does Science Work?

The real process of science

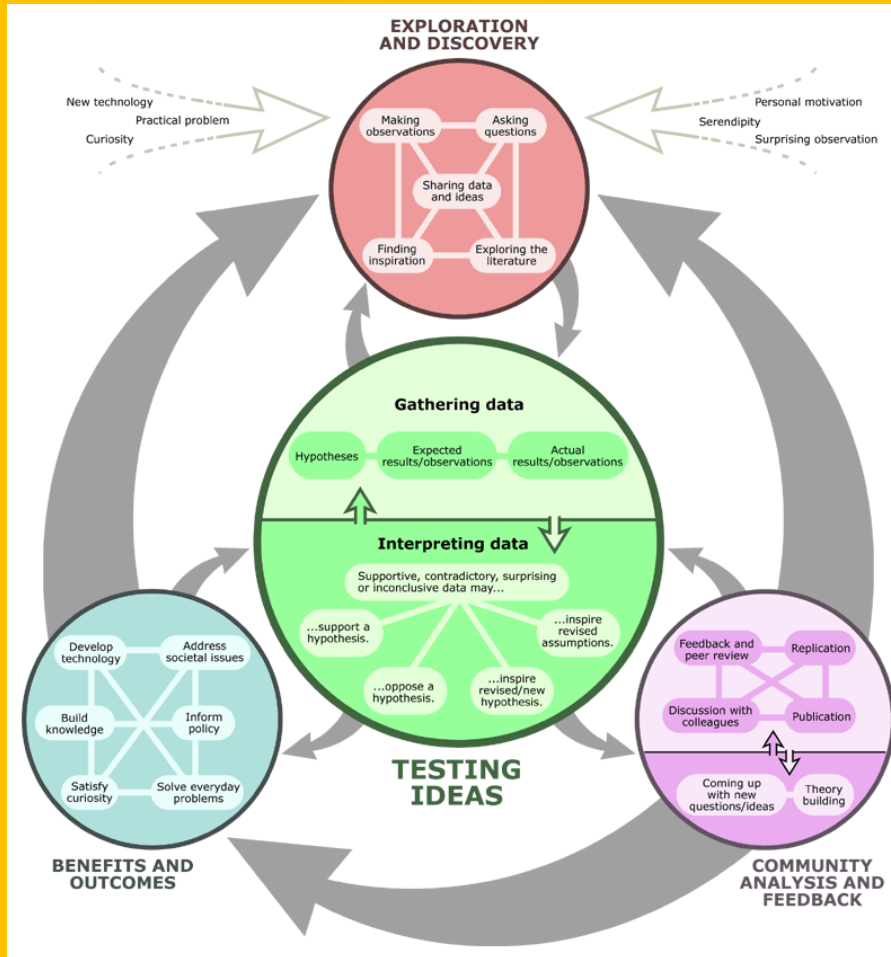
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How Does Science Work?

A blueprint for scientific investigations

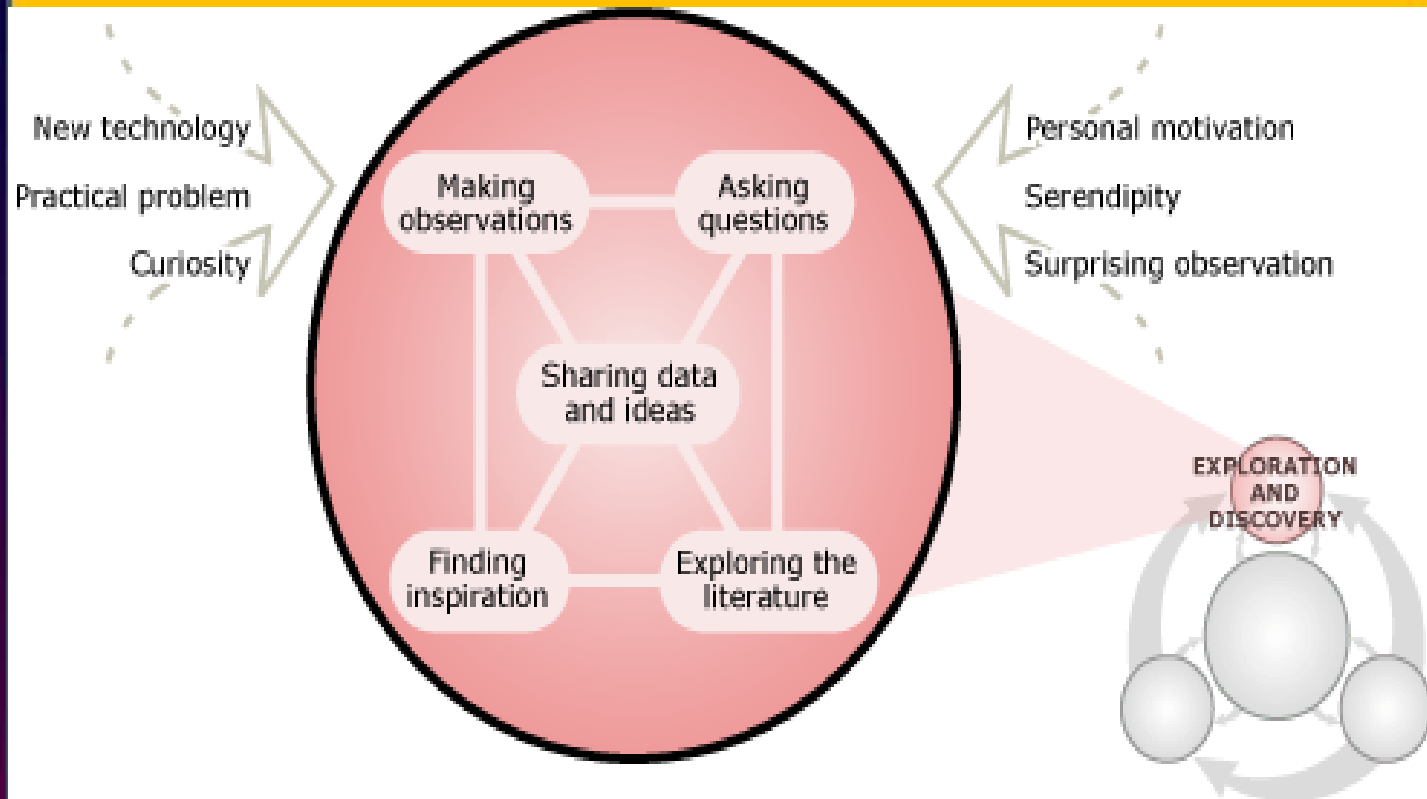
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1





How Does Science Work?

A blueprint
for scientific investigations

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1. There are many routes into the process:

- from serendipity : being hit on the head by the proverbial apple,
- concern over a practical problem : finding a new treatment for diabetes,
- technological development : the launch of a more advanced telescope,
- Curiosity : tinkering, brainstorming, trying to make some new observations, chatting with colleagues about an idea, or doing some reading.





How Does Science Work?

A blueprint for scientific investigations

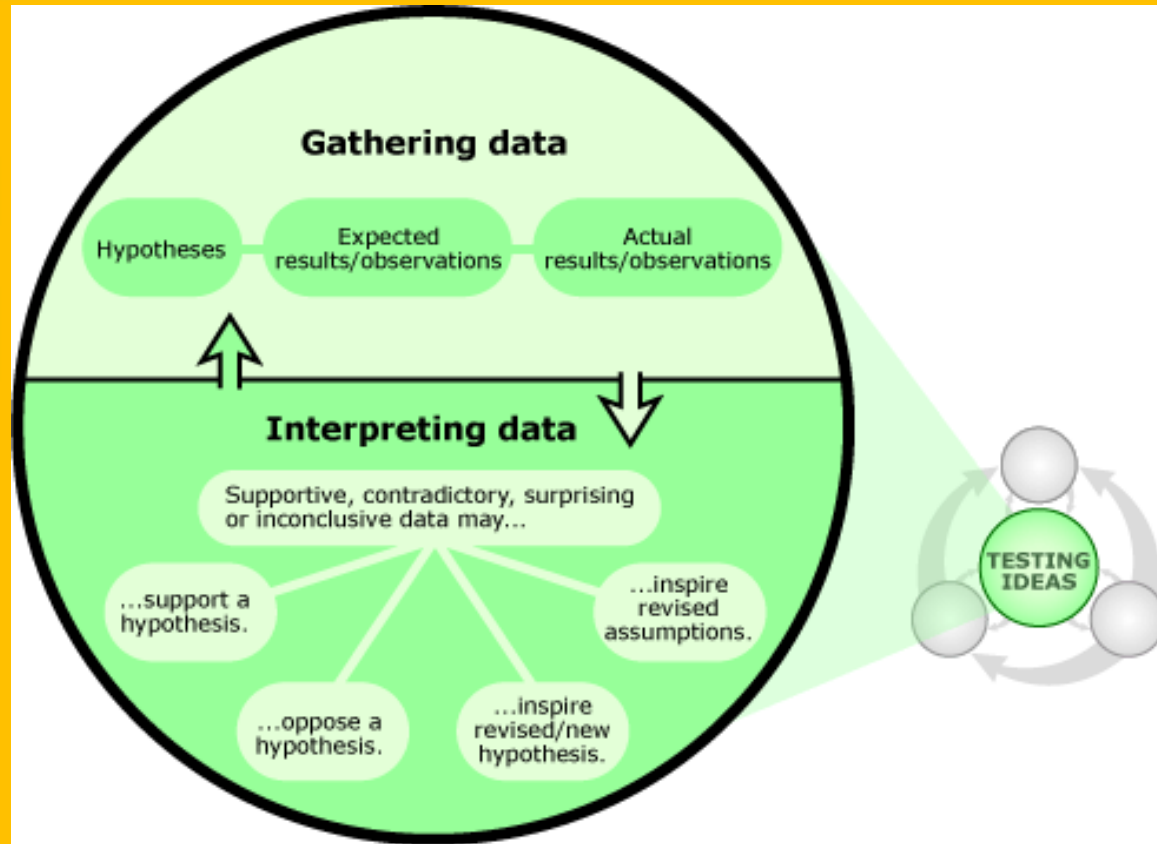
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How Does Science Work?

A blueprint for scientific investigations

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2. Scientific testing is at the heart of the process

- In science, all ideas are tested with evidence from the natural world, which may take many different forms .
- We can't move through the process of science without examining how that evidence reflects on our ideas about how the world works.





How Does Science Work?

A blueprint for scientific investigations

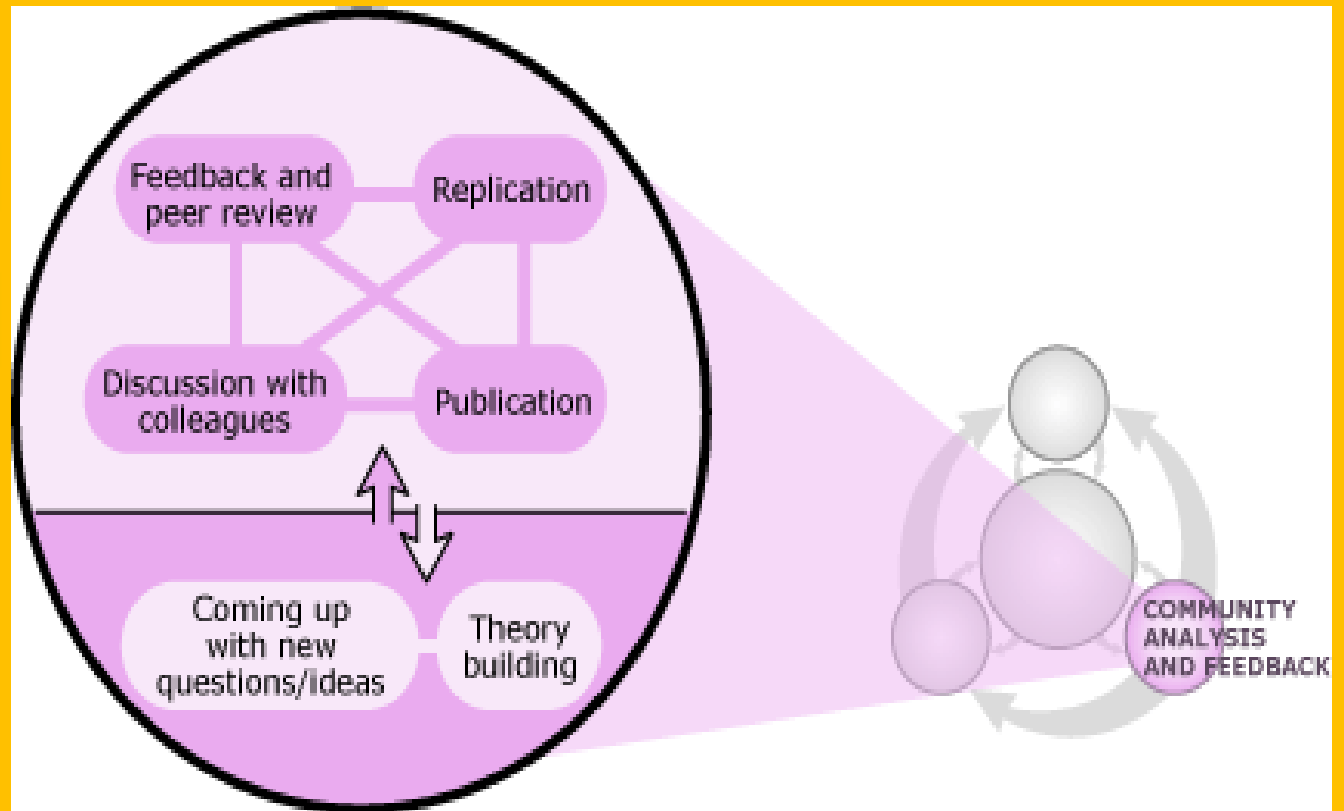
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How Does Science Work?

A blueprint for scientific investigations

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3. The scientific community helps ensure science's accuracy.

- Members of the scientific community (i.e., researchers, technicians, educators, and students, to name a few) play many roles in the process of science, but are especially important in generating ideas, scrutinizing ideas, and weighing the evidence for and against them. Through the action of this community, science is self-correcting.





How Does Science Work?

A blueprint for scientific investigations

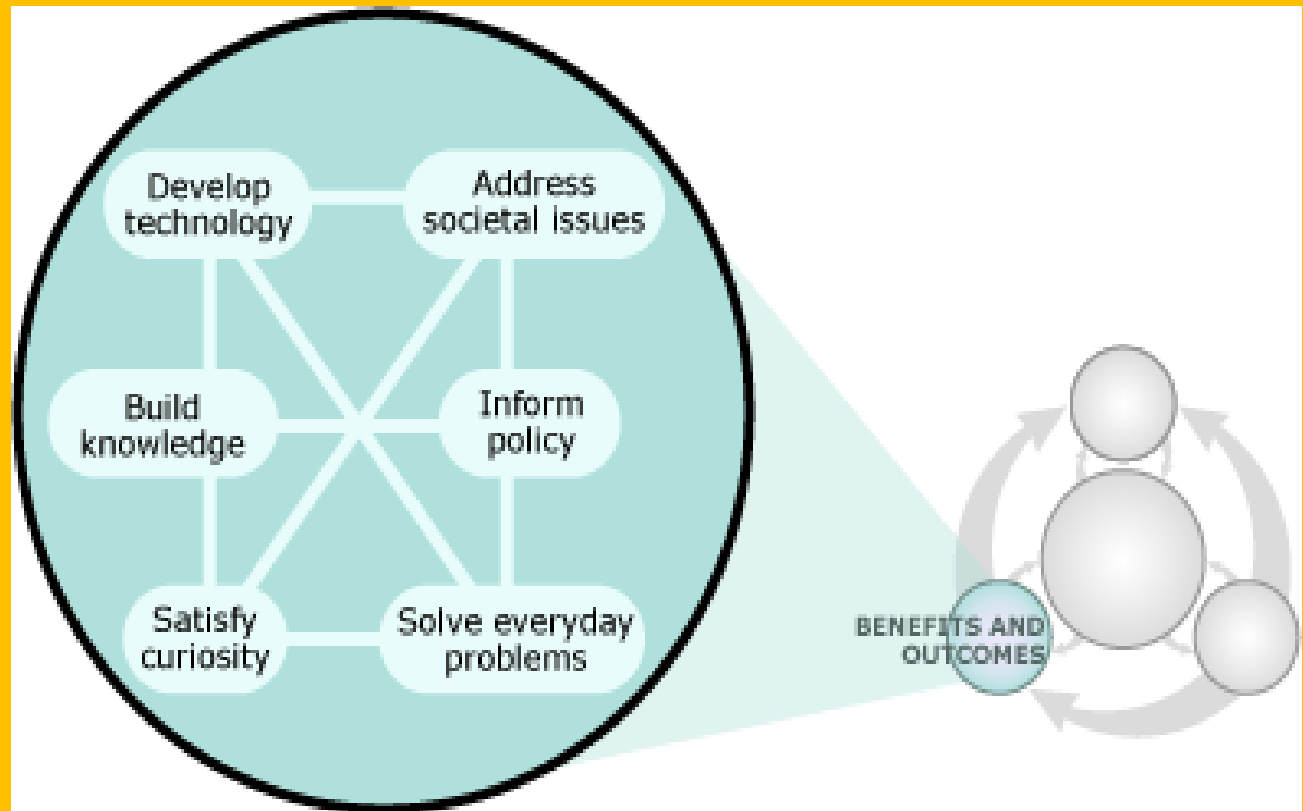
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How Does Science Work?

A blueprint for scientific investigations

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4. The process of science is intertwined with society

- The process of science :
 - is influences to society : investigations of X-rays leading to the development of CT scanners, and
 - is influenced by society : a society's concern about the spread of HIV leading to studies of the molecular interactions within the immune system.





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Science, Society, and Technology





Science and Society

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- Science is not static; it changes over time, reflecting shifts in the larger societies in which it is embedded.
- Societies have changed over time, and consequently, so has science





Science, Society, and Technology

Science in First half of the 20th century

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Evaluation

- When the world was enmeshed in war, governments made funds available for scientists to pursue research with wartime applications — and so science progressed in that direction, unlocking the mysteries of nuclear energy.





Science, Society, and Technology

Science in Second half of the 20th century

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- Modern corporations looking for income through medical treatment, drug production, and agriculture, have increasingly devoted resources to biotechnology research, yielding breakthroughs in genomic sequencing and genetic engineering.





Science Today

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- Modern foundations funded by the financial success of individuals may invest their money in ventures that they deem to be socially responsible, encouraging research on topics like renewable energy technologies.



Science, Society, and Technology



Science and our live

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- Science affects us all, every day of the year, from the moment we wake up, all day long, and through the night:
- Our digital alarm clock, the weather report, the asphalt we drive on, the bus we ride in, our decision to eat a baked potato instead of fries, our cell phone, the antibiotics that treat our sore throat, the clean water that comes from our faucet, and the light that we turn off at the end of the day have all been brought to you courtesy of science.





Science, Society, and Technology

Science and Modernity

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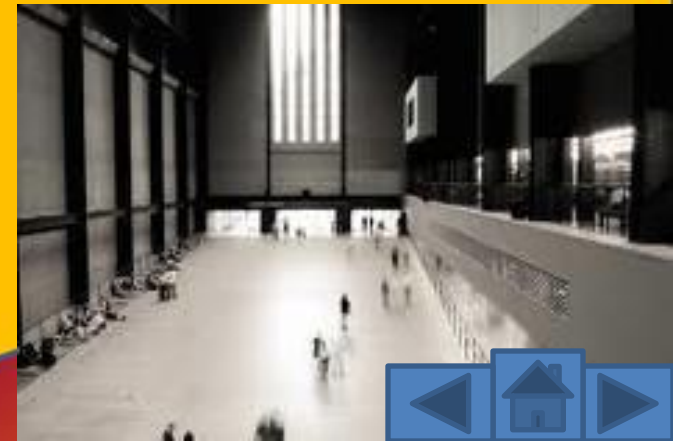
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- The modern world would not be modern at all without the understandings and technology enabled by science.
- To make it clear how deeply science is interwoven with our lives, just try imagining a day without scientific progress.





Science, Society, and Technology

Just for starters, without modern science, there would be:

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- **No Way to Use Electricity.** From Ben Franklin's studies of static and lightning in the 1700s, to Alessandro Volta's first battery, to the key discovery of the relationship between electricity and magnetism, science has steadily built up our understanding of electricity, which today carries our voices over telephone lines, brings entertainment to our televisions, and keeps the lights on.





No Plastic

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- The first completely synthetic plastic was made by a chemist in the early 1900s, and since then, chemistry has developed a wide variety of plastics suited for all sorts of jobs, from blocking bullets to making slicker dental floss.





Science, Society, and Technology

No Modern Agriculture

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- Science has transformed the way we eat today. In the 1940s, biologists began developing high-yield varieties of corn, wheat, and rice, which, when paired with new fertilizers and pesticides developed by chemists, dramatically increased the amount of food that could be harvested from a single field, ushering in the Green Revolution. These science-based technologies triggered striking changes in agriculture, massively increasing the amount of food available to feed the world and simultaneously transforming the economic structure of agricultural practices.



Science, Society, and Technology



No Modern Medicine

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- In the late 1700s, Edward Jenner first convincingly showed that vaccination worked. In the 1800s, scientists and doctors established the theory that many diseases are caused by germs. And in the 1920s, a biologist discovered the first antibiotic. From the eradication of smallpox, to the prevention of nutritional deficiencies, to successful treatments for once deadly infections, the impact of modern medicine on global health has been powerful. In fact, without science, many people alive today would have instead died of diseases that are now easily treated.





Science, Society, and Technology

Science and Quality of Live

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- Scientific knowledge can improve the quality of life at many different levels — from the routine workings of our everyday lives to global issues.
- Science informs public policy and personal decisions on energy, conservation, agriculture, health, transportation, communication, defense, economics, leisure, and exploration.
- It's almost impossible to overstate how many aspects of modern life are impacted by scientific knowledge. Here we'll discuss just a few of these examples.





Science, Society, and Technology

The impact of science and technology

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- science builds knowledge about the world, but that people decide how that knowledge should be used
- For example, science helped us understand that much of an atom's mass is in its dense nucleus, which stores enormous amounts of energy that can be released by breaking up the nucleus.
- That knowledge itself is neutral, but people have chosen to apply it in many different ways.





Science, Society, and Technology

The impact of science and technology

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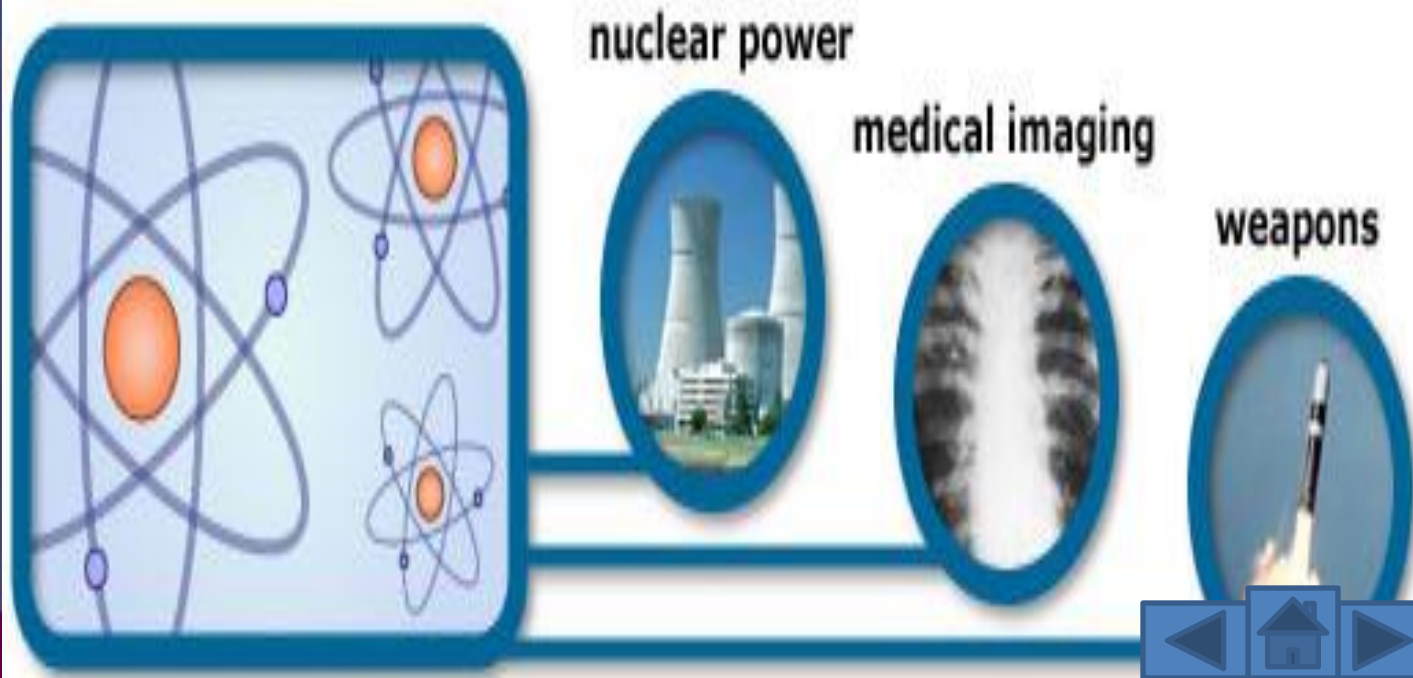
What is Science

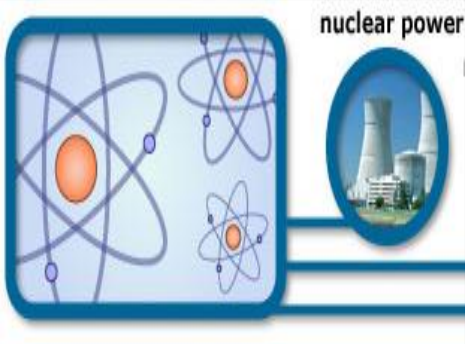
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Technology

Evaluation

- Knowledge of the atomic nucleus has been many applied in many differences way





Science, Society, and Technology

Nuclear and Energy

Introduction

What is Science

How Science Work

Science, Society &
Technology

Evaluation

- Our understanding of this basic atomic structure has been used as the basis of nuclear power plants, which themselves have many societal benefits (e.g., nuclear power does not rely on non-renewable, polluting fossil fuels) and costs (e.g., nuclear power produces radioactive waste, which must be carefully stored for long periods of time).





Nuclear and Medicine

Introduction

What is Science

How Science Work

Science, Society &
Technology

Evaluation

- That understanding has also been used in many modern medical applications (e.g., in radiation therapy for cancer and in medical imaging, which can trace the damage caused by a heart attack or Alzheimer's disease).



weapons



Science, Society, and Technology

Nuclear and Defense

Introduction

What is Science

How Science Work

Science, Society &
Technology

Evaluation

- During World War II, that knowledge also clued scientists and politicians in to the fact that atomic energy could be used to make weapons. Once a political decision was made to pursue atomic weapons, scientists worked to develop other scientific knowledge that would enable this technology to be built.





Science, Society, and Technology

From cathodes to crystallography

