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What is science?

To observe the physical and biological environment carefully,

Look for any meaningful patterns and relations,

Make and use new tools to interact with nature, and build conceptual models to understand the world.

-----This human endeavour is science. It is a dynamic, expanding body of knowledge covering ever new domains of experience.

Why do we (students) need to know how scientific knowledge is developed?

Understand what makes science science, to distinguish science as a field of human endeavor from other human endeavors.

To be able to use this understanding to identify scientific arguments and explanations from other kinds, and to be able to evaluate them in scientific terms.

What do students need to know about scientific knowledge?

Sandoval (2005)-- Scientific knowledge as constructed. Science is something that people do and create.

Scientific methods are diverse: there is no single “method” which applies to all scientific inquiries (experiments may be conducted in some fields, but not in others).

Science depends on ways of evaluating scientific claims (e.g., care, and fit with existing knowledge).

Scientific knowledge comes in different forms, which vary in their explanatory and predictive power (e.g., theories, laws, hypotheses;

The social side of science

Science as a method to know about nature --- a huge database of knowledge that has led to technology to transform society

Community endeavor. Contrary to the stereotype of solitary lab work, scientists interact with colleagues to collaborate on projects, review each other's work, share information, and brainstorm new ideas.

Maintain a set of cultural norms and expectations: scrutinize ideas, be honest, give credit where credit is due, and work within the ethical guidelines of the community.

The scientific community contributes to the progress of science in many different ways, from providing checks and balances to facilitating specialization — and all of those functions are furthered by a diverse scientific community.

Science simply works better when lots of different sorts of people participate in it!

Expects certain conduct from its community members.

Rigorous scrutiny, questioning,

Honesty, integrity, and objectivity,

Acknowledging others' work, giving due credit,

Adherence to ethical guidelines:

Scientific journals have elaborate policies –is there financial benefit from the study to the author, use of research animals, how human participants in a study must be treated.

Funding agencies maintain guidelines that must be followed to get research funds.

Scientific organizations like the National Academies (in the U.S.) assemble scientists to draw up guidelines that balance ethical concerns with its potential rewards (eg. embryonic stem cell research)

Science and society

Societies have changed over time, and so has science.

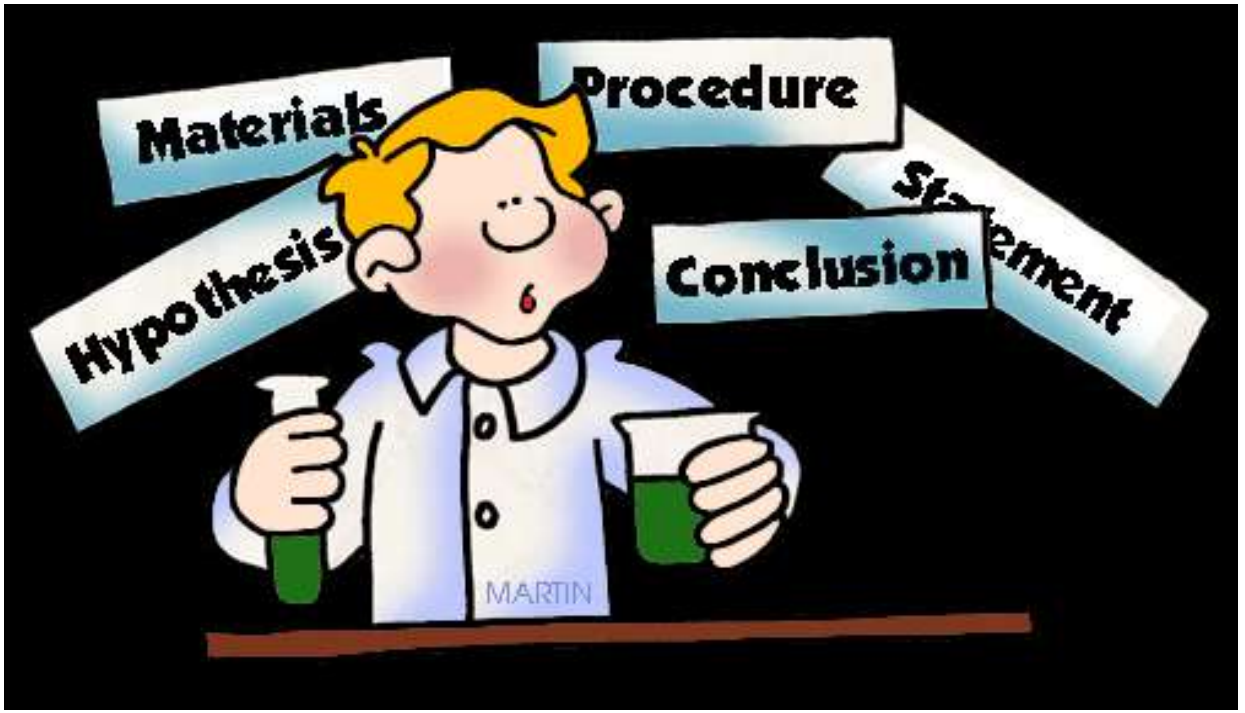
For example, during the first half of the 20th century, governments made funds available for scientists to pursue research with wartime applications — and so science progressed in that direction, unlocking the mysteries of nuclear energy.

Market forces leading to scientific advances- example, modern corporations look for income through drug production, or agriculture, devote resources to biotechnology research, yielding breakthroughs in genomic sequencing and genetic engineering.

Science is not static; it changes over time, reflecting shifts in the larger societies in which it is embedded.

Nature of Science in the larger canvas...

Some science educators have defined the nature of science as "the values and assumptions inherent to the development of scientific knowledge" (Lederman, 1992).



The Nobel Prize Medal

The Nobel Prize Medal. Photo: Alexander Mahmoud 2018

Alfred Nobel (1833-1896)

Born in Stockholm (Sweden), received good education from private teachers on natural sciences, languages and literature

By the age of 17, Alfred Nobel was fluent in Swedish, Russian, French, English and German

In 1867, he patented nitroglycerine under the name of dynamite. By the time of his death he had 355 patents. He focused on the development of explosives technology as well as other chemical inventions, including materials such as synthetic rubber and leather, artificial silk, etc.

- He started factories & laboratories in almost 90 different places in more than 20 countries. He was constantly traveling and Victor Hugo described him as “Europe’s richest vagabond”.

- Alfred Nobel’s greatness lay in his ability to combine within himself the scientist and inventor with the industrialist. He was also deeply interested in social and peace-related issues. He had a great interest in literature and wrote his own poetry and dramatic works.

- The Nobel Prizes became an extension and a fulfillment of his lifetime interests. When his will was opened it came as a surprise that his fortune was to be used for Prizes in Physics, Chemistry, Physiology or Medicine, Literature and Peace.

On November 27, 1895, Alfred Nobel had signed his third and last will. When it was opened and read after his death, the will caused a lot of controversy, in Sweden and internationally, as he had left much of his wealth for the establishment of a prize.

His family opposed the establishment of the Nobel Prize, and the prize awarders he named refused to do what he had requested in his will. It was five years before the first Nobel Prize could be awarded in 1901.

His will: ***All my remaining realisable assets are to be disbursed as follows: the capital, converted to safe securities ..., is to constitute a fund, the interest on which is to be distributed annually as prizes to those who, during the preceding year, have conferred the greatest benefit to humankind.***

The interest is to be divided into five equal parts and distributed as follows:

one part to the person who made the most important discovery or invention in the field of physics;

one part to the person who made the most important chemical discovery or improvement;

one part to the person who made the most important discovery within the domain of physiology or medicine;

one part to the person who, in the field of literature, produced the most outstanding work in an idealistic direction;

and one part to the person who has done the most or best to advance fellowship among nations, the abolition or reduction of standing armies, and the establishment and promotion of peace congresses.

Who can nominate?

The Nobel Committee for Physics sends confidential forms to persons who are competent and qualified to nominate.

Who is eligible?

The candidates eligible are those nominated by qualified persons who have received an invitation from the Nobel Committee to submit names for consideration.

Qualified Nominators!!

The right to submit proposals for the award of a Nobel Prize in Physics shall, by statute, be enjoyed by:

1. Swedish and foreign members of the Royal Swedish Academy of Sciences;
2. Members of the Nobel Committee for Physics;
3. Nobel Laureates in Physics;
4. Tenured professors in the Physical sciences at the universities and institutes of technology of Sweden, Denmark, Finland, Iceland and Norway, and Karolinska Institutet, Stockholm;
5. Holders of corresponding chairs in at least six universities or university colleges (normally, hundreds of universities) selected by the Academy of Sciences with a view to ensuring the appropriate distribution over the different countries and their seats of learning; and
6. Other scientists from whom the Academy may see fit to invite proposals.

Timeline for selection of Nobel Laureate

September:	Nomination forms are sent out
February:	Deadline for submission
March-May:	Consultation with experts
June-August:	Writing of the report
September:	Committee submits recommendations
October:	Nobel Laureates are chosen
December:	Nobel Laureates receive their prize

About Nomination Disclosure

The statutes of the Nobel Foundation restrict disclosure of information about the nominations, whether publicly or privately, for 50 years.

1901- 2018, the Nobel Prizes (+Economic Sciences) 590 times

Nobel Prize	Number of Prizes	Number of Laureates	Awarded to 1	Awarded to 2	Awarded to 3
Physics	112	210	47	32	33
Chemistry	110	181	63	23	24
Medicine	109	216	39	33	37
Literature	110	114	106	4	-
Peace	99	106+27	67	30	2
Economic	50	81	25	19	6
Total	590	935	347	141	102

Years without Nobel Prizes; *49, mostly during World War I (July, 1914 - Nov, 1918) and World War II (Sept, 1939 -Sept, 1945)*

Physics: **1916,** 1931, 1934, **1940, 1941, 1942**

Chemistry: **1916, 1917,** 1919, 1924, 1933, 1940, 1941, 1942

Medicine: **1915, 1916, 1917, 1918**, 1921, 1925, **1940, 1941, 1942**

Literature: **1914, 1918,** 1935, **1940, 1941, 1942, 1943**

Peace: **1914, 1915, 1916, 1918,** 1923, 1924, 1928, 1932, **1939, 1940, 1941, 1942, 1943,** 1948, 1955, 1956, 1966, 1967, 1972

The Youngest Nobel Laureates

Category	Name	Year of Award	Age of Nobel Laureate
Physics	William Lawrence Bragg	1915	25
Chemistry	Frédéric Joliot	1935	35
Physiology or Medicine	Frederick Banting	1923	32
Literature	Rudyard Kipling	1907	41
Peace	Malala Yousafzai	2014	17

The Oldest Nobel Laureates

Chemistry	**John B. Fenn**	2002	85
Physiology or Medicine	**Peyton Rous**	1996	87
Literature	**Doris Lessing**	2007	88
Peace	**Joseph Rotblat**	1995	87
Economic Sciences	**Leonid Hurwicz**	2007	90

Indian Nobel Prize Winners

Rabindranath Tagore for Literature (1913)
"Because of his profoundly sensitive, fresh and beautiful verse, by which, he has made his poetic thought, expressed in his own English words, a part of the literature of the West."

C. V. Raman for Physics (1930)
"For his work on the scattering of light and for the discovery of the effect named after him."

Mother Teresa for Peace (1979)
"For work undertaken in the struggle to overcome poverty and distress, which also constitutes a threat to peace."

Amartya Sen for Economic Sciences (1998)
"For his contributions to welfare economics."

Kailash Satyarthi for Peace (2014)
"For their struggle against the suppression of children and young people and for the right of all children to education."

Overseas citizens of Indian origin

Har Gobind Khorana for Physiology/Medicine (1968)
"For their interpretation of the genetic code and its function in protein synthesis."

Subrahmanyan Chandrasekhar for Physics (1983)
"For his theoretical studies of the physical processes of importance to the structure and evolution of the stars."

Venkatraman Ramakrishnan in Chemistry (2009)
"For studies of the structure and function of the ribosome."

Two Nobel Laureates declined the prize

1. **Jean-Paul Sartre**, awarded the 1964 Nobel Prize in Literature, declined the prize because he had consistently declined all official honours

2. **Le Duc Tho**, awarded the 1973 Nobel Peace Prize jointly with US Secretary of State Henry Kissinger. They were awarded the Prize for negotiating the Vietnam peace accord. Le Doc Tho said that he was not in a position to accept the Nobel Peace Prize, citing the situation in Vietnam as his reason.

Forced to decline the Nobel Prize

Four Nobel Laureates have been forced by authorities to decline the Nobel Prize

1. Adolf Hitler forbade three German Nobel Laureates, **Richard Kuhn, Adolf Butenandt and Gerhard Domagk,** from accepting the Nobel Prize

All of them could later receive the Nobel Prize Diploma and Medal, but not the prize amount

2. **Boris Pasternak**, the 1958 Nobel Laureate in Literature, initially accepted the Nobel Prize but was later coerced by the authorities of the Soviet Union, his native country, to decline the Nobel Prize

Nobel Laureates under arrest at the time of the award

Three Nobel Laureates were under arrest at the time of the award of the Nobel Prize, all of them Nobel Peace Prize Laureates:

- **German pacifist and journalist Carl von Ossietzky**
- **Burmese politician Aung San Suu Kyi**
- **Chinese human rights activist Liu Xiaobo**

Between 1901 and 2018, the Nobel Prizes and the Prize in Economic Sciences were awarded 590 times to 935 people and organizations.

With some receiving the Nobel Prize more than once, this makes a total of 904 individuals and 24 organizations.

How many women?

During this period, the Nobel Prize and Prize in Economic Sciences have been awarded to women 52 times.

One woman, Marie Curie, has been honoured twice. This means that 51 women in total have been awarded the Nobel Prize between 1901 and 2018. Of these, 20 prizes have been for science (19 women)

Source: https://www.nobelprize.org

Physics (3, with more than 50 years gap)

1903 - *Marie Curie*

1963 - Maria Goeppert-Mayer

2018 - Donna Strickland

Chemistry (5)

1911 - *Marie Curie*

1935 - Irène Joliot-Curie

1964 - Dorothy C Hodgkin

2009 - Ada E. Yonath

2018 - Frances H. Arnold

Physiology or Medicine (12, small gaps)

1947 - Gerty Cori

1977 - Rosalyn Yalow

1983 - Barbara McClintock

1986 - Rita Levi-Montalcini

1988 - Gertrude B. Elion

1995 - Christiane Nüsslein-Volhard

2004 - Linda B. Buck

2008 - Françoise Barré-Sinoussi

2009 - Elizabeth H. Blackburn

2009 - Carol W. Greider

2014 - May-Britt Moser

2015- Youyou Tu

Peace (17)

1905 – Bertha von Suttner
1931 – Jane Addams
1946 – Emily Greene Balch
1976 – Betty Williams
1976 – Mairead Corrigan
1979 – Mother Teresa
1982 – Alva Myrdal
1991 – Aung San Suu Kyi
1992 – Rigoberta Menchú Tum
1997 – Jody Williams
2003 – Shirin Ebadi
2004 – Wangari Maathai
2011 – Ellen Johnson Sirleaf
2011 – Leymah Gbowee
2011 – Tawakkol Karman
2014 – Malala Yousafzai
2018 – Nadia Murad

Literature (14)

1909 - Selma Lagerlof
1926 - Grazia Deledda
1928 - Sigrid Undset
1938 - Pearl Buck
1945 - Gabriela Mistral
1966 - Nelly Sachs
1991 - Nadine Gordimer
1993 - Toni Morrison
1996 - Wislawa Szymborska
2004 - Elfriede Jelinek
2007 - Doris Lessing
2009 - Herta Muller
2013 - Alice Munro
2015 - Svetlana Alexievich

Five women who missed out on the Nobel prize

Donna Strickland was awarded the 2018 Nobel prize for physics jointly with Arthur Ashkin and Gérard Mourou

For their work on high-intensity lasers.

It's the first time in 55 years that a woman has won this prestigious prize, but why has it taken so long?

Source: https://amp.theguardian.com

Jocelyn Bell Burnell (1943-)

Discovered the first radio pulsars in 1967
(when she was a PhD student at Cambridge)

The Nobel prize that recognised this landmark discovery in 1974, however, went to her male supervisor, Antony Hewish

Photograph: Daily Herald Archive/SSPL via Getty Images

Source: https://amp.theguardian.com

Lene Hau (1959-)

Hau is best known for leading the research team at Harvard University in 1999

Often topping Nobel prize prediction lists, could 2019 be Hau's year?

Photograph: Rick Friedman/Corbis via Getty Images

Source: https://amp.theguardian.com

Vera Rubin (1928-2016)

Photograph: The Washington Post/Getty Images

Rubin discovered dark matter in the 1980s, opening up a new field of astronomy

She died in 2016, without recognition from the committee

Source: https://amp.theguardian.com

Chien-Shiung Wu (1912-1997)

Chien-Shiung Wu's
"Wu experiment" helped disprove the "law of conservation of parity", a fundamental particle physics law

Her experimental work was instrumental but never honoured.

Instead, her male colleagues won the 1957 Nobel prize for their theoretical work behind the study.

Photograph: Robert W. Kelley/The LIFE Picture Collection/Gett

Source: https://amp.theguardian.com

Lise Meitner (1878-1968)

Physicist Lise Meitner led groundbreaking work on the discovery of nuclear fission, the splitting of an atomic nucleus into smaller nuclei.

However, the discovery was acknowledged by the 1944 Nobel prize for chemistry, which was won by her male co-lead, Otto Hahn.

Photograph: Bettmann Archive

Source: https://amp.theguardian.com

Activity in Collaboratively Understanding Biology Education (CUBE) lab, HBCSE

- Predict this year's Nobel Winners and gather your own Award in 2015
- Nobel Prize (Physiology & Medicine) Prediction Campaign in 2016
- Nobel Prize Prediction Campaign (Physiology & Medicine) in 2017

Source:

https://www.nobelprize.org/

Thank you

Nobel Prize awarded to organizations for Peace
(27 times between 1901 and 2018 of which 24 are individual organizations)

- International Committee of the Red Cross, 1917, 1944 & 1963
- UNHCR, the Office of the United Nations High Commissioner for Refugees, - 1954 and 1981
- International Campaign to Abolish Nuclear Weapons (ICAN) – 2017
- National Dialogue Quartet – 2015
- Organisation for the Prohibition of Chemical Weapons (OPCW) -2013
- European Union (EU) – 2012
- Intergovernmental Panel on Climate Change (IPCC) – 2007
- Grameen Bank- 2006

- Doctors Without Borders -1999
- International Campaign to Ban Landmines - 1997
- Pugwash Conferences on Science and World Affairs - 1995
- United Nations Peacekeeping Forces - 1988
- International Physicians for the Prevention of Nuclear War - 1985
- Amnesty International -1977
- International Labour Organization (I.L.O.) - 1969
- United Nations Children's Fund (UNICEF) – 1965
- Friends Service Council (The Quakers) - 1947
- American Friends Service Committee (The Quakers)- 1947
- Nansen International Office for Refugees in 1938
- Permanent International Peace Bureau in 1910
- Institute of International Law in 1904
- International Atomic Energy Agency (IAEA) in 2005
- United Nations (U.N.) in 2001