TOK

Natural Sciences



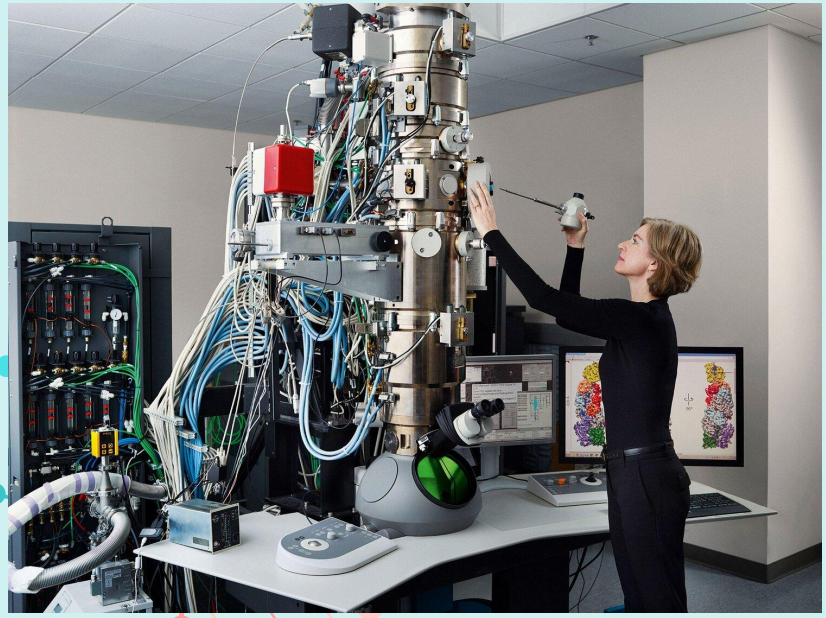
1. TOK or TOI?
2. Science? Or is it science-wanna-be?
3. Ethics
4. Methodology
5. Transfer of Things
6. Sharing Information
7. Copyrights



01

TOK or TOI?

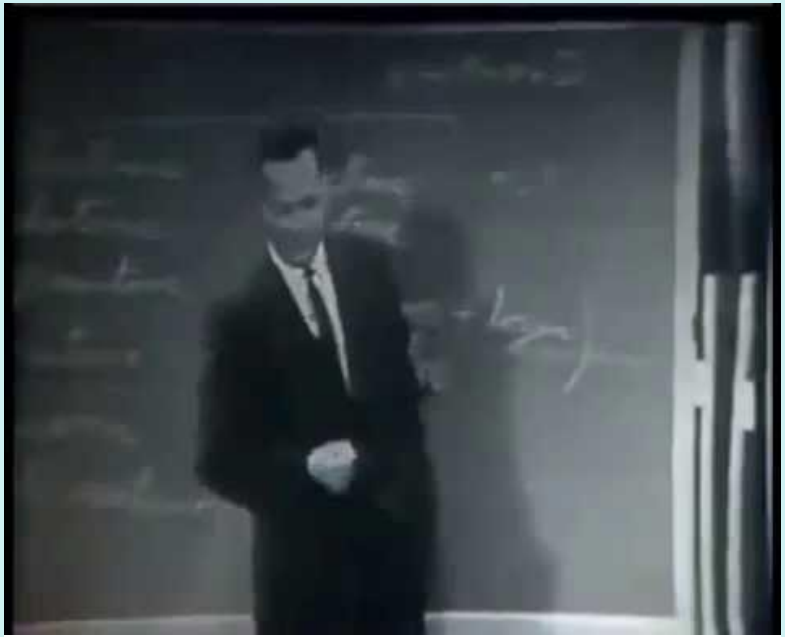
Do we really know what we know?



Jennifer Doudna, CRISPR pioneer. Photo source: How to edit a human: for decades scientists aspired to modify the code of life. Tom Whipple meets Jennifer Doudna, who succeeded. The Economist 1843 Magazine. Tom Whipple, July 3rd 2018.

Look underneath the green stools for post-it notes

What sentence do they make?



"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it disagrees with experiment, it's wrong." - Richard Feynman

It's Just a Theory

Is Theory of Ignorance (TOI) a better name for this course than Theory of Knowledge (TOK)?



Trios Work

In his TED talk about Ignorance, we quickly recognize that Firestein does not mean "stupidity" or "indifference to fact or reason or data." In the context of being a real scientist what attitudes of mind about ignorance is Firestein actually championing?

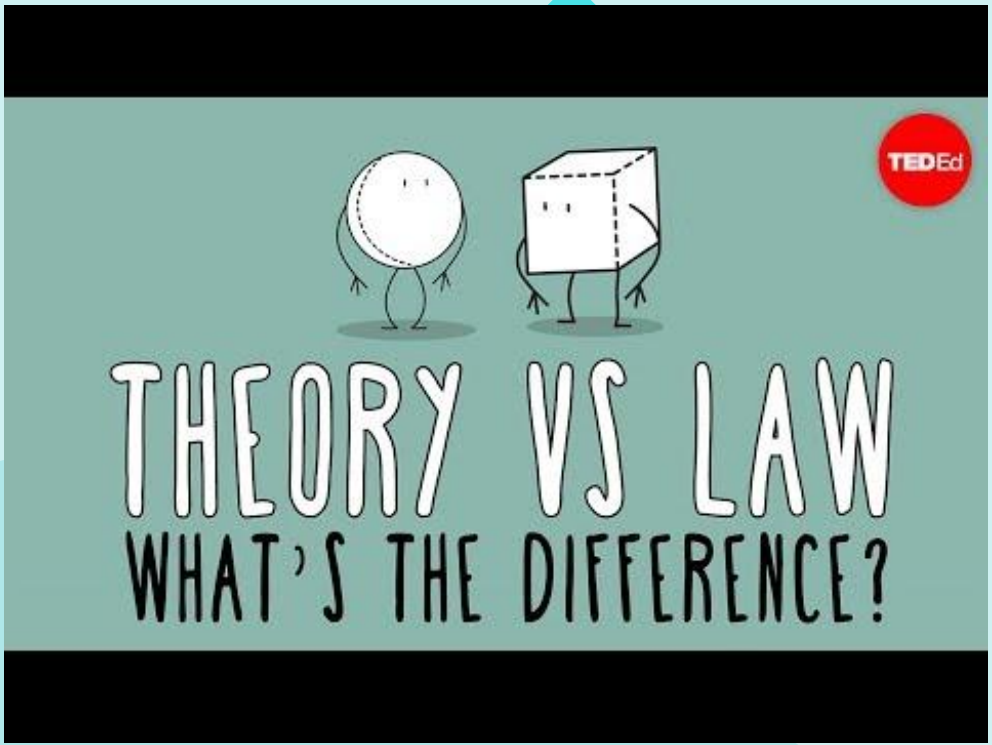
Firestein mentions with plenty of irony that his fact-filled Neuroscience text book weighs more than two normal human brains. If the boundaries of knowledge and ignorance are so important, to what extent is it still important to learn facts?

Based on what you already know about the scientific method, to what extent is it accurate to say that science is all about "question propagation"? Can we say the same about History? How about other Areas of Knowledge?

Work on this worksheet and answer its guiding questions



Knowledge Question



To what extent is knowledge invented and to what extent is it discovered?

Knowledge Question

Can science teach us everything?





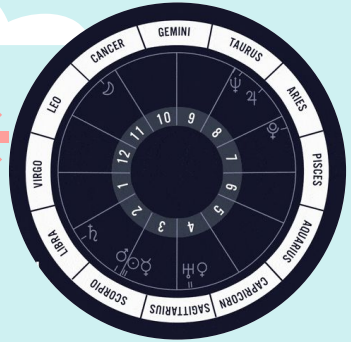
02

SCIENCE?

Or is it a
science-wanna-be?



WHAT'S IN THE STARS



Horoscope

Sit with people of your star sign. Do you have similar character traits? Read your horoscope for the day here?
What does it make you feel?

What's my sign?

Aries (March 21 – April 19)
Taurus (April 20 – May 20)
Gemini (May 21 – June 20)
Cancer (June 21 – July 22)
Leo (July 23 – August 22)
Virgo (Aug 23 – Sep 22)
Libra (Sep 23 – Oct 22)
Scorpio (Oct 23 – Nov 21)
Sagittarius (Nov 22 – Dec 21)
Capricorn (Dec 22 – Jan 19)
Aquarius (Jan 20 – Feb 18)
Pisces (Feb 19 – Mar 20)

ASTROLOGY IN A NUTSHELL



the story of psychologist Forer and the test he ran with his students

Evidence

Read this article on how astrology works. Explain

Answer the following questions

1. Do you believe your horoscope? If so, what do you mean by “believe” in this case?
2. Does it provide testable statements?
3. Does it give advice?
4. To what extent are predictions and advice dependent on your own interpretation of what they mean within your own life?
5. Do you find it entertaining?

“We do know stuff, even if all knowledge is partial and tentative. Not knowing everything is not the same thing as knowing nothing. And when you take knowing nothing as premise, then, of course, you can believe in anything. Reality is then whatever you want it to be. All news is fake news...

“That, of course, is where critical thinking comes in... Scientific literacy is good, but not enough. Education is not enough. General intelligence is not enough. You need to know how to think.”

Steven Novella

What is Pseudoscience?

SPACE

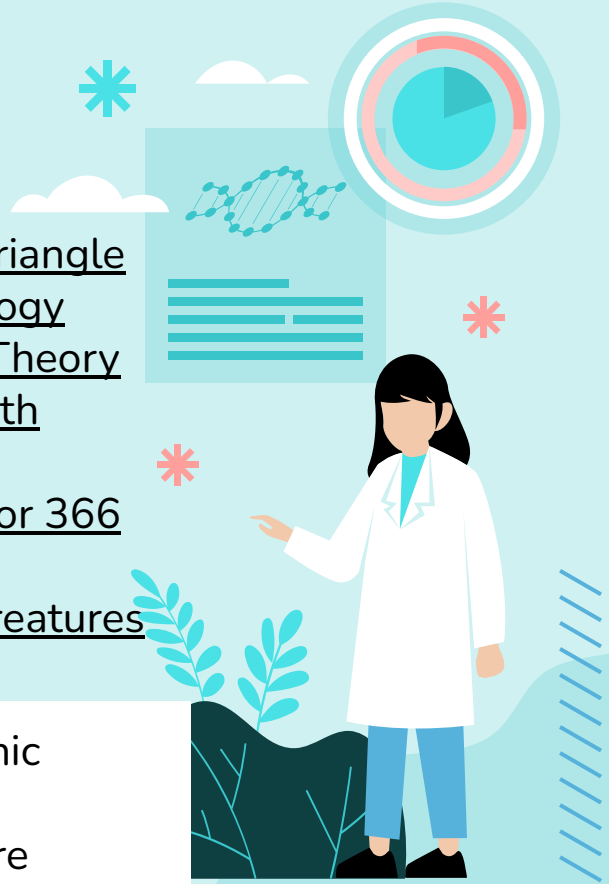
- 2012 Doomsday Scare
- Ancient Aliens -
- Apollo Moon Landing Hoax -
- Astrology
- Crop Circles -
- Face on Mars

EARTH

- Bermuda Triangle
- Cryptozoology
- Flat Earth Theory
- Hollow Earth Theory
- Megalithic or 366 Geometry
- Mythical Creatures

- Levitation
- Numerology
- Body Language
- Feng Shui

- Homeopathic medicine
- Acupuncture
- Detox



What separates science from pseudoscience? What are the characteristics of “good” science? To what extent can we expect scientific knowledge to be “certain”?

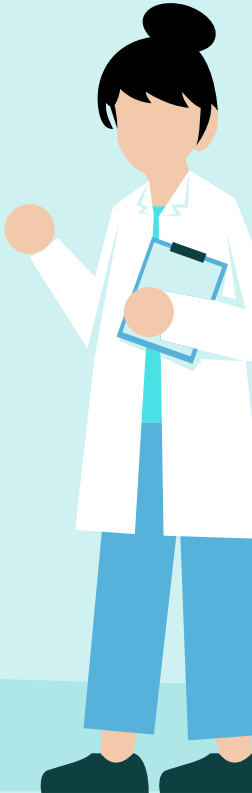




How might members of the public judge whether to accept scientific findings if they do not have detailed scientific knowledge?

How is it that scientific knowledge is often shared by large, geographically spread and culturally diverse groups?

How do scientists make use of, or work around, their intuitions?





03

Ethics

What really defines what’s right and what’s wrong?

Doppelgänger

Research

What does Doppelgänger mean?

Opinion

Would you want one? Why would anyone want it?

Facts

What are the chances that you find one?



Emilie Sagée

What if...?

What if natural scientists had an ethical "carte blanche"?
What kind of things would we (want to) research?
What might we know?
What might be the possible consequences of scientific knowledge acquired through such means?



- Brainstorm the above questions in groups on large sheets of paper/write on tables.
- For each possible consequence of your "ethical carte blanche", think of other subsequent consequences (be creative!)
- Walk around the tables and compare your group's findings with those of others.
- What criteria could we use to decide whether the pursuit and/or possession of scientific knowledge is ethical?

How to assess the ethicality of an act?

Beneficence

To do good; to provide benefit for the majority

Nonmaleficence

To avoid doing or causing harm

Autonomy

Respecting the right to choose and give informed consent

Justice

Equal and fair access and distribution of resources; benefit to some is not to the detriment of others

QUALITY OF LIFE

Relating to the fulfilment and satisfaction a person can have with the life they are able to lead

QUANTITY OF LIFE

Relating to the length of life a person will have

SANCTITY OF LIFE

Relating to the idea that all life is sacred and should be valued equally





- Should scientists use research obtained from unethical experiments?
- Are there some things that we shouldn't research (and, therefore, know) because of their potential ethical issues?
- Do scientists have an ethical obligation to consider the uses of their research?

Prepare for a
Socratic Seminar



Topics for Debate

Choose one for a socratic seminar (rubric)

A Should animals be subjected to serious diseases to research treatments for humans?

B Should people with HIV have to disclose this information?

C Should people be paid to take part in experimental drug trials?

D Should genetic screening be mandatory?

04

Methodology

What can we do?



The Scientific Method

Lord Kelvin

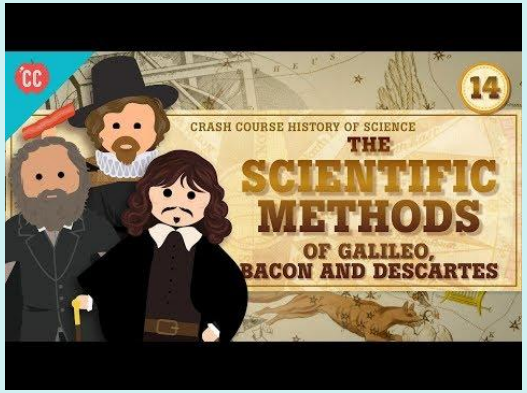
When you cannot measure, your knowledge is meagre and unsatisfactory.

Jacob Bronowski

Science is a way of describing reality; it is therefore limited by the limits of observation, and it asserts nothing which is outside observation.



The scientific method



Go to Menti

Experiment here

How easy is it to write a methodology? You need a 3-fold paper

One

Follow the directions I give you, show me what shape you produced

Two

On the second fold of your paper, draw your own geometric figure

Three

Without showing it to your shoulder partner, give him/her directions to replicate it

Four

How successful were they?

Is this peer review?



05

Transfer of Things

Is it contagious?

What does the word contagious mean?
How does it apply to situations other than disease?

<u>Changing Habits</u>
Why would we want to change (or gain) habits?
Devise your own related knowledge question.



What else is contagious? ?



06

Sharing Information

What should we keep as a secret?

Finding Links

01

Podcasts

Listen to one of the following:
1 or 2.

02

Pair Work

Make sure you and your partner have different podcasts

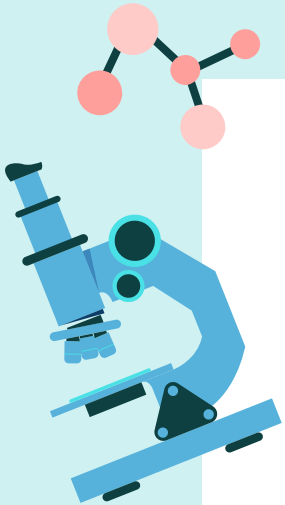
03

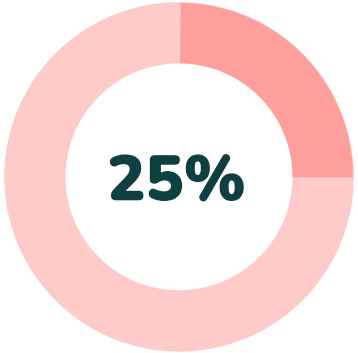
Wrap it up

Using Mindmup, work together to summarize your podcasts and then to find links between them

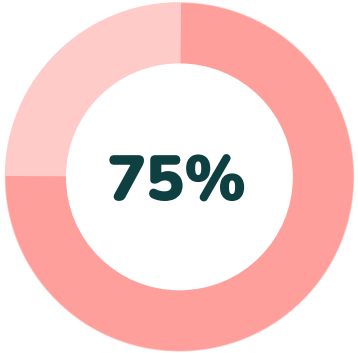
What should be the percentage of?

Set the percentage



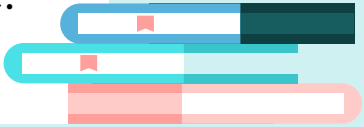


Our personal medical information published?

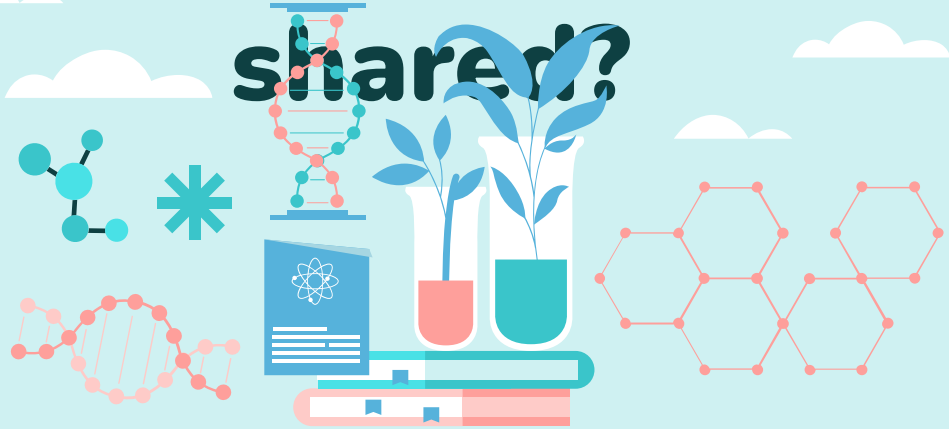


General discoveries shared with the public?





What information do you expect is not shared?



Science, medicine, astronomy, etc

07

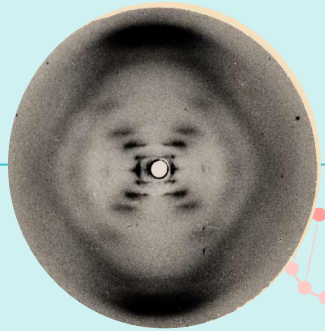
Copyrights

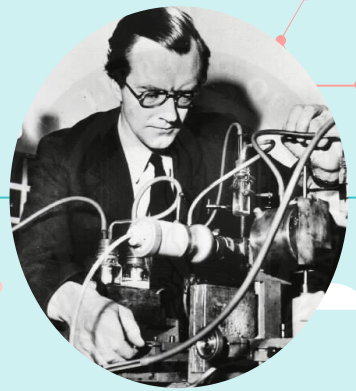
Who’s the real scientist?



The Discovery of DNA





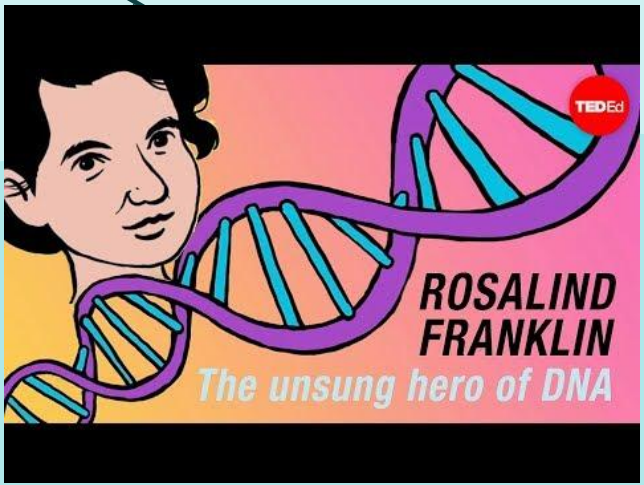




Look at this article

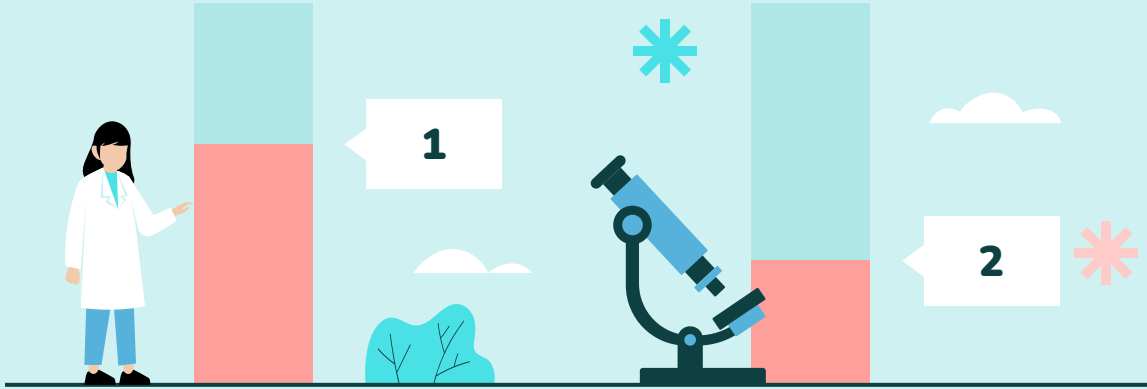
Step into the shoes of Watson, Crick, Wilkins and Franklin

How important is Franklin?



- Watson and Crick declare in their opening sentence, “This structure has novel features which have considerable biological importance.” With all the benefit of hindsight, assess whether Watson and Crick were fully aware of the significance of their discovery? Could they have been joking?
- Did you understand all or most of Watson and Crick’s paper?
- In your view did Watson and Crick do any science?
- What is the relationship between Experimentalists and Theorists in the Natural Sciences?

Nature

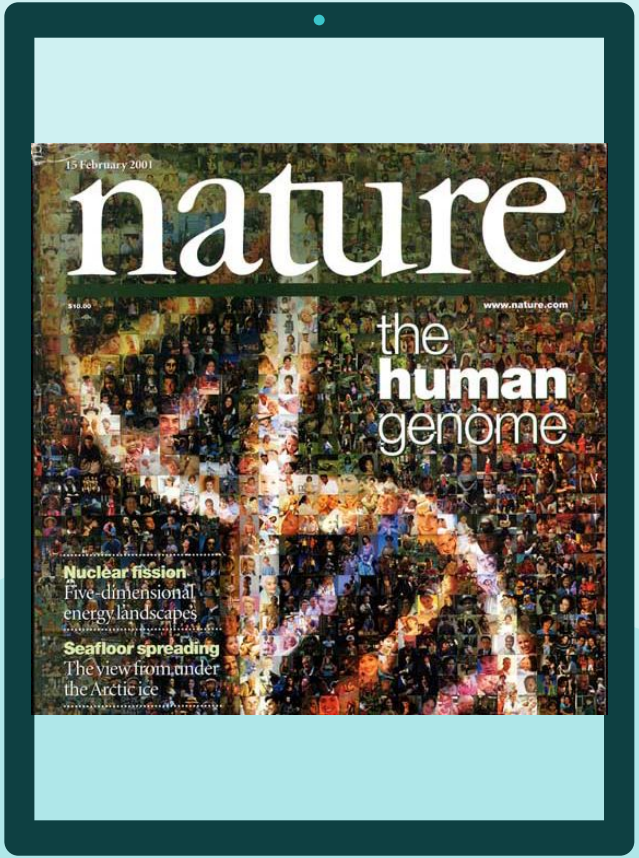


Read the policy for publication and peer review at "Getting Published in Nature: The Editorial Process" at the **Nature website,** or from a **downloaded pdf.**

Look at an <u>issue</u> of Nature. read or attempt to read:
1. The Nature's mission
2. Several items from "News in Brief"
3. A single page advertisement
4. A full-sized "Article" or "Letter"

What are your first impressions? How much of what you just read could you understand? What are the essential differences between Watson and Crick's 1953 paper and the much more recent "Article" or "Letter" that you attempted to read?
What are the essential differences between what you read in Nature and the science presented in the text book used in your IB science class?
What are the advantages and disadvantages of extreme specialization in the various branches of science? Do your conclusions apply to other Areas of Knowledge?

Choose the most hermetic, difficult, technical and obscure sentence found in your set of Nature journals add here





08

Evil Science

Are we born evil or are we born good?
Go to mentimeter

Points to consider

- Thomas Malthus
- One of the first recorded uses of biological warfare occurred in 1347, when Mongol forces are reported to have catapulted plague-infested bodies over the walls into the Black Sea port of Caffa (now Feodosiya, Ukraine), at that time a Genoese trade centre in the Crimean Peninsula. Some historians believe that ships from the besieged city returned to Italy with the plague, starting the Black Death pandemic that swept through Europe over the next four years and killed some 25 million people (about one-third of the population).
- Talk about a biological weapon
- De Buono Hats - you're using biological weapons



One member of your group is the President.
The group will summarize the issues to the president, and discuss ways to define American national interests then present the policy response.

The structure of mustard gas accidently led to the discovery of an immunodepressant.
In your journal, talk about the accidental scientific discoveries.

What are the most important scientific discoveries?

Knowledge Questions

Choose a question from this list
Here is the rubric
Post here



To what extent does our interpretation of knowledge from the past allow us to reliably predict the future?

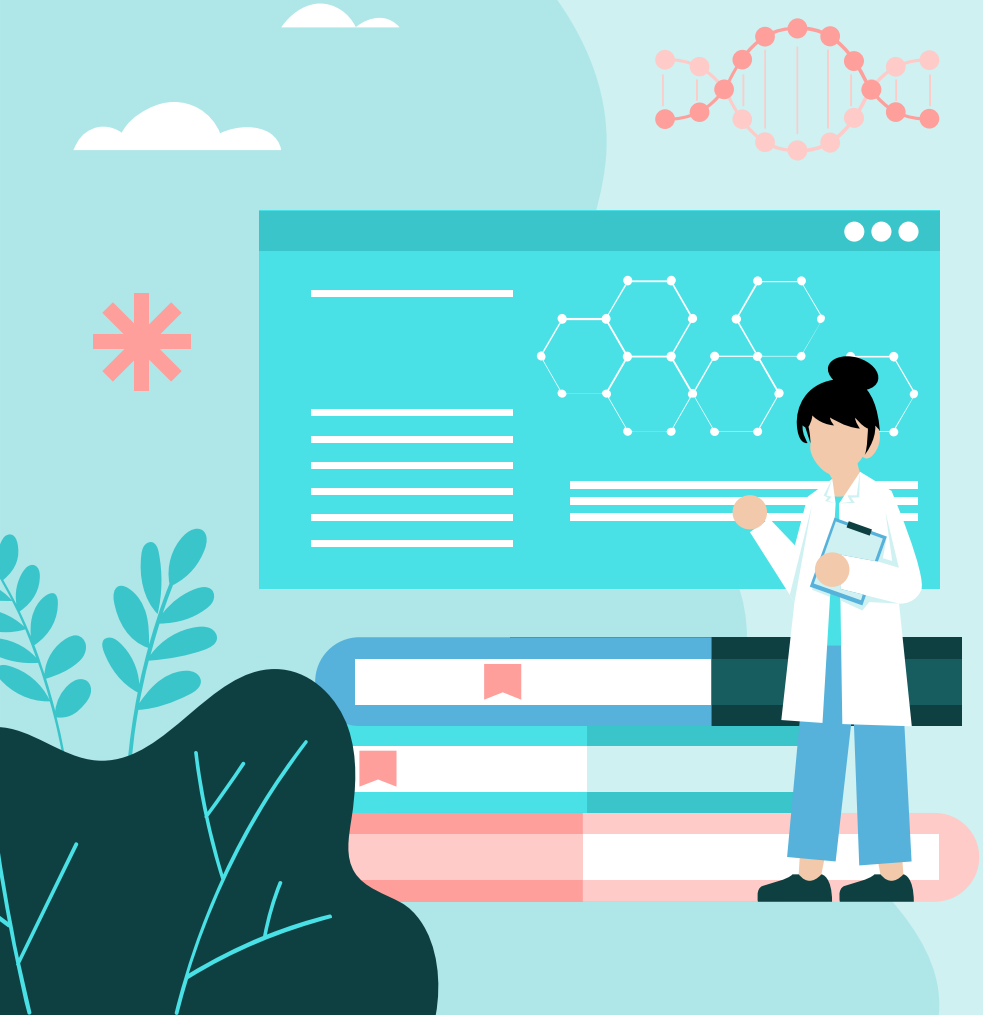
Socratic Seminar

Genetic Modification

Should we consume genetically modified food?
Should we genetically modify our babies?
Should we risk genetic modification?

Rubric





THANKS!

DO YOU HAVE ANY QUESTIONS?

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