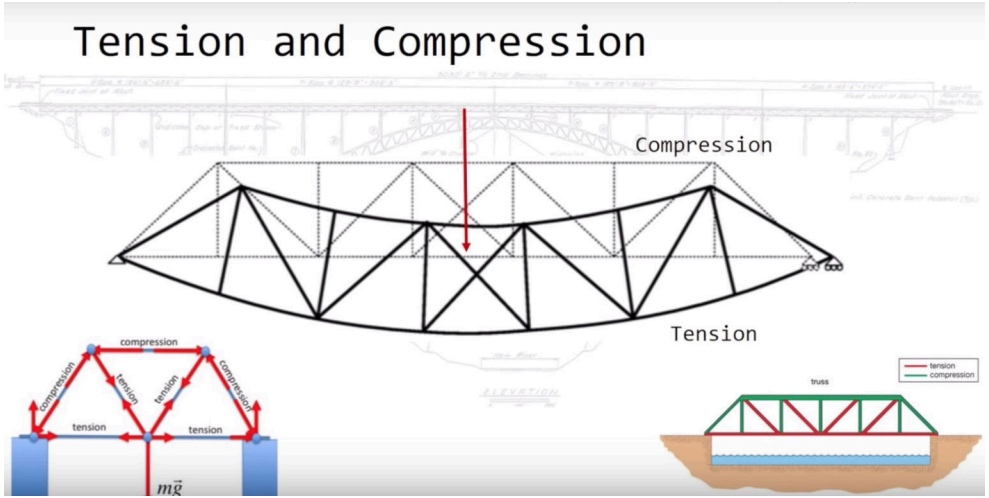
Warm-Up Question:

(Why) is outreach about complex science important?

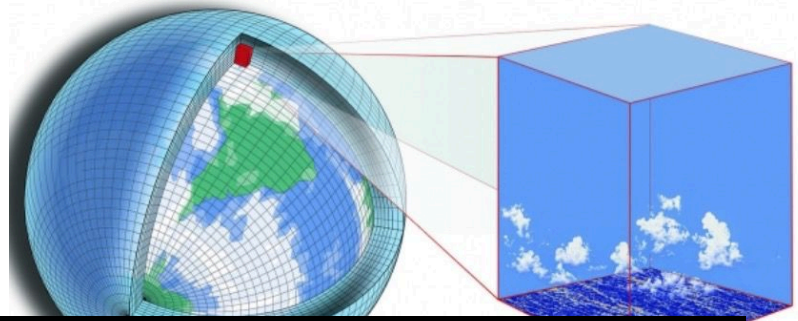
Science Outreach at the Cutting Edge: Design-a-palooza

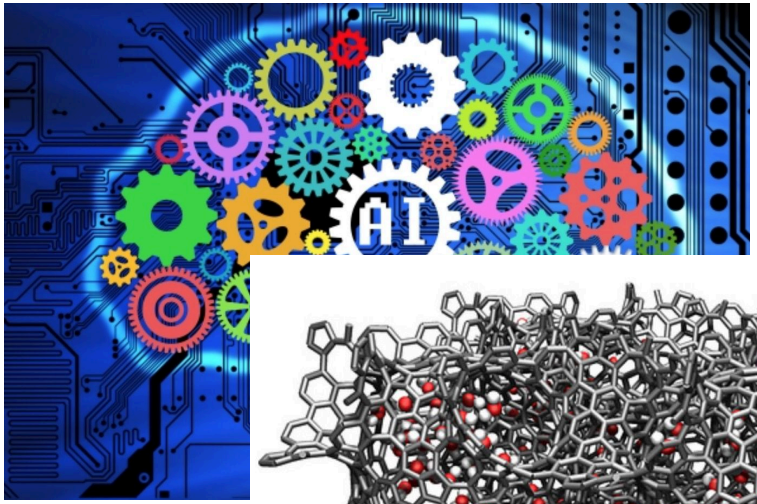
Claire Pillsbury	*Exploratorium*
David Sittenfeld	*MOS Boston*
Brian Mernoff	*MIT Museum*
Donna Francis	*Ontario Science Centre*
Ari Krakowski	*Lawrence Hall of Science*
Lee Bishop	*Lawrence Hall of Science*

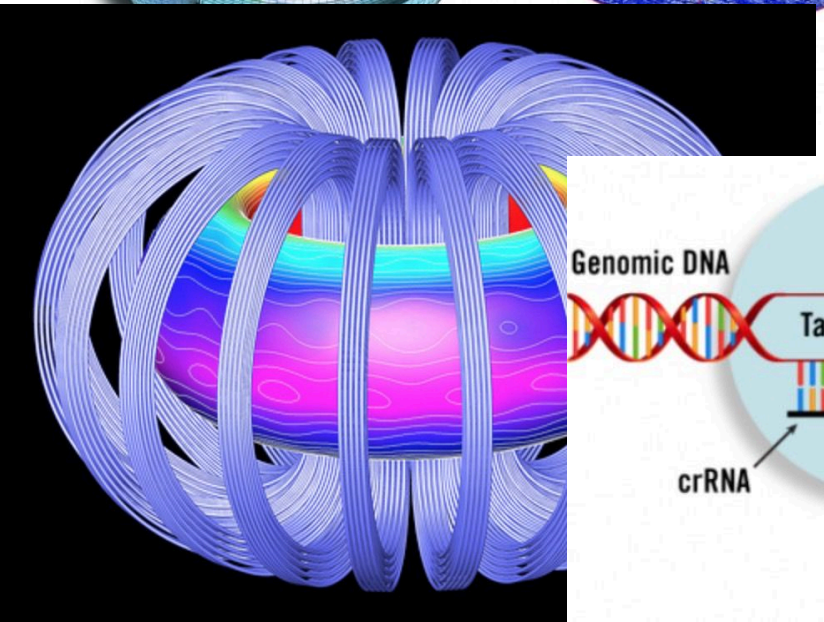
What is complex science?

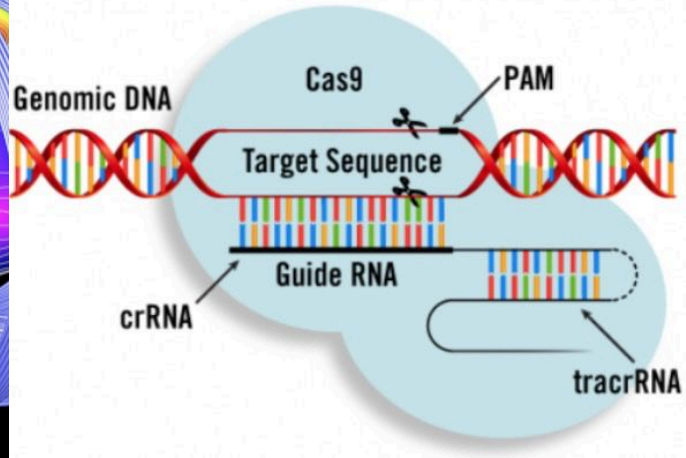


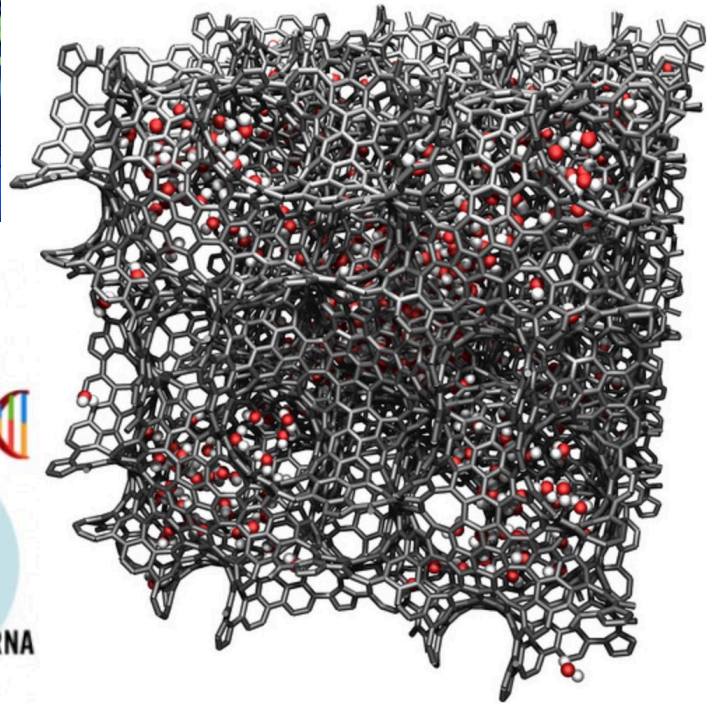
Complex!!




AI




Genomic DNA
Cas9
PAM
Target Sequence
Guide RNA
crRNA
tracrRNA



(Why) is outreach about complex science important?

Possible reasons
Potential to **solve** real world **problems**.
Will affect people's **lives**.
Fascinating. Cultivates wonder and awe.
Innovative. Never been done before.
Might **inspire** someone to pursue a science career.
Might **broaden participation** in science.
To bolster **public support** for scientific research.
Required for federal or state funding.
Helps scientists improve their communication skills.

(Why) is outreach about complex science important?

Possible reasons	**Who those reasons likely matter to:**		
	Scientists	Educators	"General public"
Potential to **solve** real world **problems**.	Yes	Yes	Yes
Will affect people's **lives**.	Yes	Yes	Yes
Fascinating. Cultivates wonder and awe.	Maybe	Yes	Varies
Innovative. Never been done before.	Yes	Maybe	Varies
Might **inspire** someone to pursue a science career.	Maybe	Yes	No
Might **broaden participation** in science.	Maybe	Yes	No
To bolster **public support** for scientific research.	Yes	Maybe	No
Required for federal or state funding.	Yes	No	No
Helps scientists improve their communication skills.	Yes	No	No

Session Outline

- Panelist Introductions ~15 min
- Design-a-palooza Overview ~5 min
- Panelists play 1 round up front ~5 min
- Audience (in groups) plays ~2 rounds ~35 min
- Reflection & wrap-up ~10 min

Panelist Introductions

- Name, Institution, and Role
- Describe one challenge you faced in communicating complex science and how you overcame it (or didn’t overcome it).

Design-a-palooza Rules

- Host will roll dice to randomly select (*for the entire room*):
  - **Cutting edge science topic**
- Each table/group will roll dice to randomly select
  - **Target age group**
- Participants have 10 minutes to read the topic description then brainstorm, discuss, and iterate on possible formats and approaches.

Design-a-palooza Rules

- Example formats - ***anything**,* including:
  - Facilitated drop-in activity
  - Facilitated classroom
  - Science show
  - Forum
  - Exhibit
  - Web-based / mobile app
  - AR/VR
  - Camps
  - etc....

Design-a-palooza Rules

Cutting Edge Science Topics
(same for the entire room)

1. Gene editing
2. Artificial intelligence
3. Materials science
4. Exoplanet research
5. Microbiome
6. Cybersecurity

Target Age Groups
(different for each table/group)

1. pre-K
2. K-5
3. Middle schoolers
4. High schoolers
5. Multi-age (e.g. families)
6. Adult

Topic: Gene editing
Age: Pre -K

Topic: Microbiome

Age: different for every table

Topic: Artificial Intelligence

Age: different for every table

Communicating Complex Science

Challenges?

Opportunities?

Questions?

Creating community

- http://bit.ly/complexscience

Cybersecurity

The protection of computer systems from theft, unauthorized access, disruption, and damage. Sometimes referred to as computer security or information technology security.

- Includes:
  - improved design of hardware & software tools
  - identity authentication services
  - network access control
  - training the public
- Current & future relevance:
  - communication systems
  - power distribution systems
  - financial institutions
  - networked smart devices

Microbiome

All of the microscopic organisms (e.g. bacteria, archaea, fungi, viruses) that inhabit a particular place such as an ecosystem or organism. Scientists sometimes use this term to refer to the genetic material of all the microorganisms in a particular place.

- Examples:
  - human microbiome (skin, gut, mouth)
  - soil microbiome
  - atmospheric microbiome
  - deep ocean microbiome
- Current research:
  - microbiome species composition
  - role of specific organisms in given microbiome
  - Connections to human & environmental health

Exoplanet Research

The study of objects orbiting stars other than our sun.

One goal of this research is to find and understand Earth-like planets around nearby stars. After discovering the exoplanets, scientists can look for signs of life by studying their atmosphere.

There are two ways to find exoplanets, both involving repeated measurements of light from stars:

- transit photometry - starlight dims as exoplanet passes between the star and Earth
- doppler spectroscopy - starlight changes frequency as it is pulled by the orbiting exoplanet

Gene Editing

The modification of the genes of a living organism by deleting, replacing, or inserting DNA sequences, with the goal of changing or understanding the impact on the organism's traits.

- Genes are sections of DNA that code for proteins.
- Proteins are the workhorse molecules in cells that determine organisms' traits.
- Edits to genes in reproductive cells can be passed down to future generations.
- CRISPR-Cas9 is a relatively new gene editing system that has made gene editing easier and more widely used.

(continued on back)

Materials Science

The study of the structure and properties of new materials (often solids) and how those are affected by the material's composition and processing history. Current areas of research include:

- *nanomaterials* - single units are smaller than 10 millionths of a meter; examples include carbon nanotubes and magnetic nanoparticles.
- *biomaterials* - made by organisms or designed to interface with them; examples include artificial heart valves, contact lenses, and bone cement.
- *semiconductors* - have tunable electronic properties and form the basis for traditional computers
- *superconductors* - conduct electricity with no energy loss; applications ranging from medicine to power transmission

Artificial Intelligence (AI)

Refers broadly to machines or computer systems that can analyze new data without being programmed to deal with predefined scenarios. There is significant debate about whether AI is a threat or boon to humanity, but most agree that the field will shape society in critical ways in the coming years.

- Pattern recognition modalities:
  - Supervised learning - the algorithm is given examples that include inputs and outputs to learn how to predict outputs from new inputs.
  - Unsupervised learning - the algorithm identifies new patterns and relationships within data.
- Relies on machine learning algorithms, such as:
  - simple - *decision trees*
  - complex - *neural networks*; inspired by brain processing; may one day produce machines with intellectual capacity surpassing that of humans.

Notes & brainstorming space

(continued on front)