How Science Works:
Its Processes, Nature, And Limits

Lifetime Learning Institute Forum
November 6, 2019

Jay Labov
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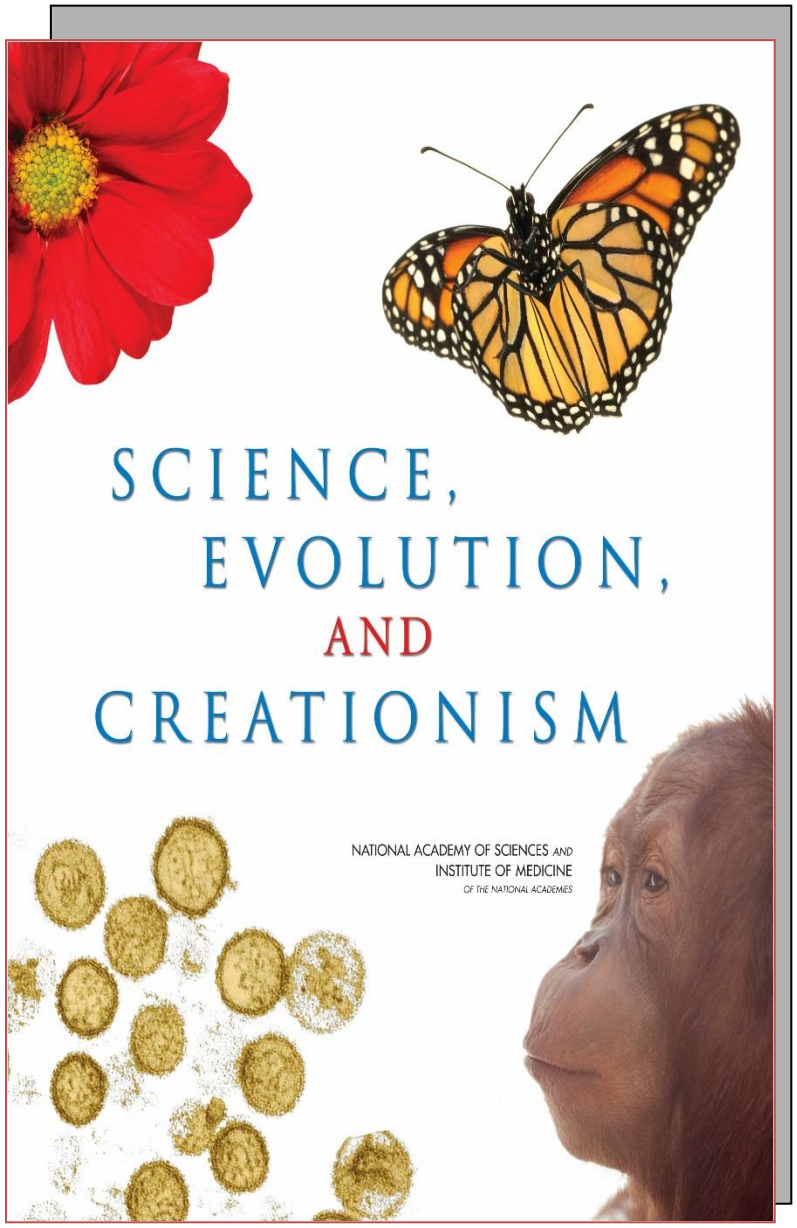
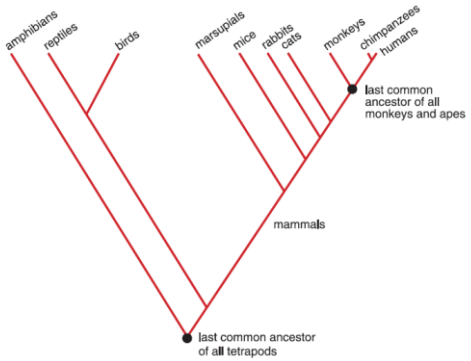


Available for free electronic download at:

http://nap.edu/sec

Summary brochures are available here.

Unpacking the Science of Evolutionary Biology

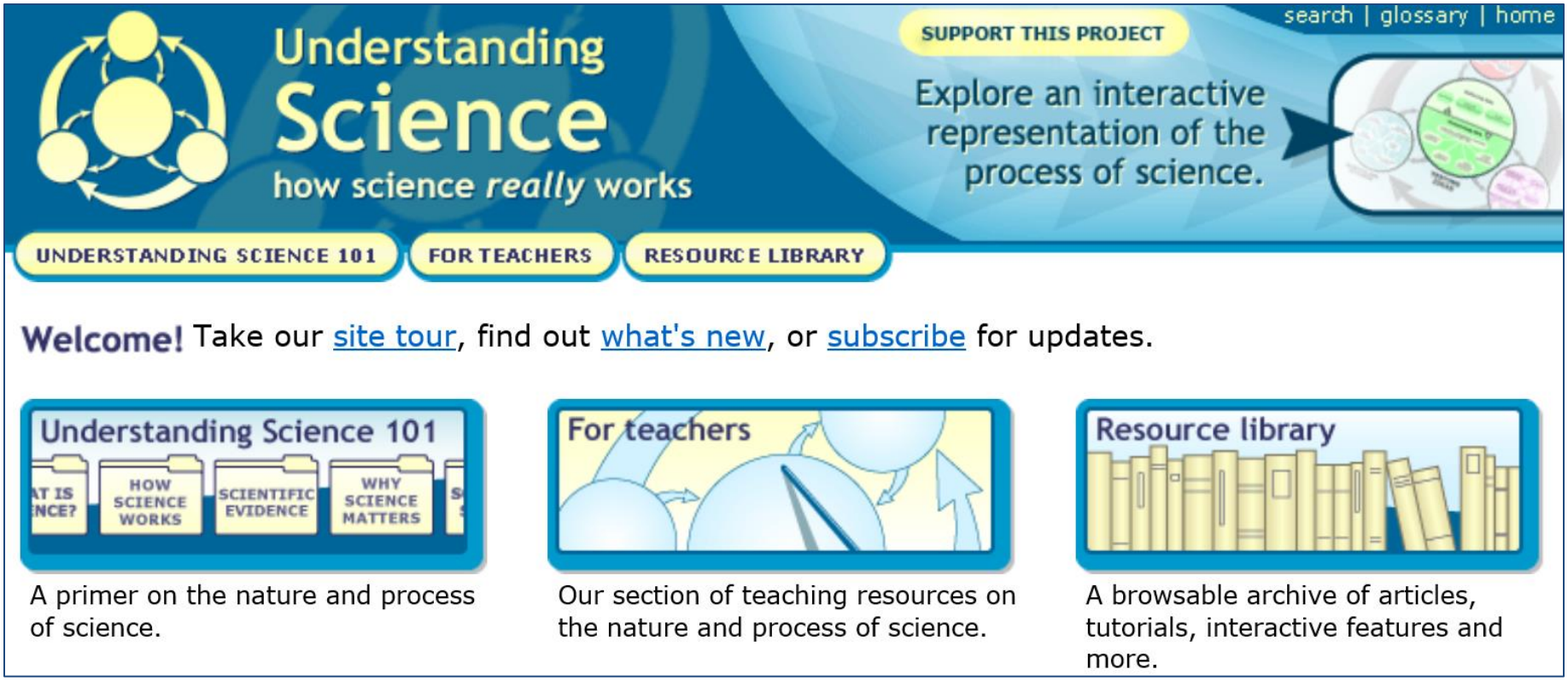


Lifetime Learning Institute

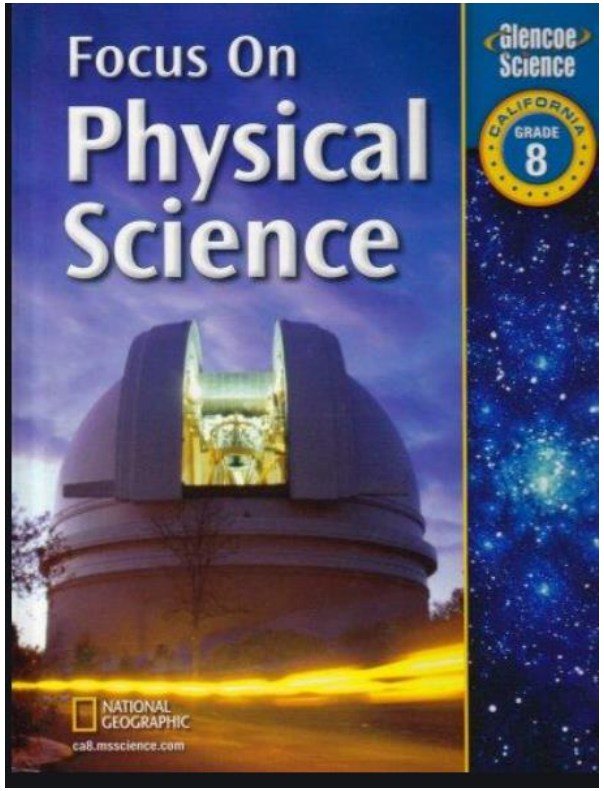
March 30 and April 6, 2020

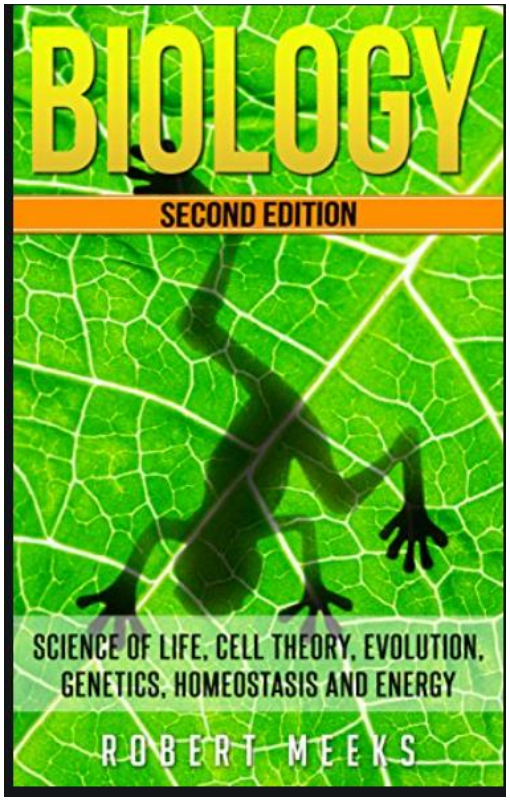
St. Matthew's Church

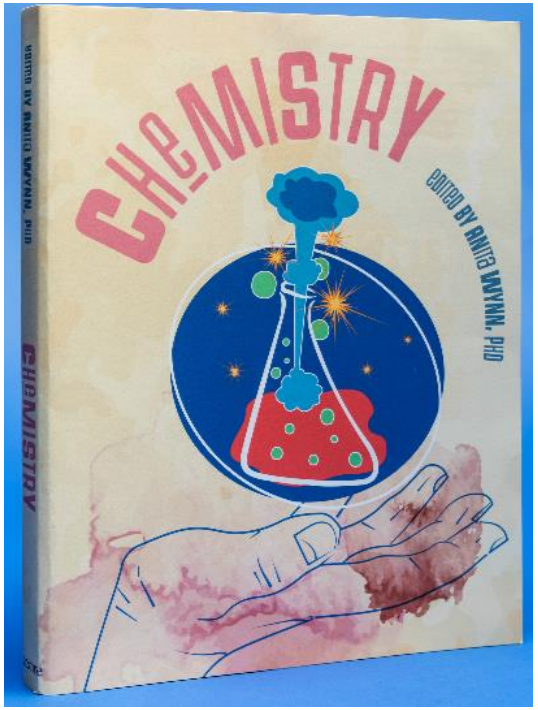
Annandale



https://undsci.berkeley.edu/


Focus On
Physical Science
Glencoe Science
CALIFORNIA
GRADE 8
NATIONAL GEOGRAPHIC
ca8.msscience.com


BIOLOGY
SECOND EDITION
SCIENCE OF LIFE, CELL THEORY, EVOLUTION, GENETICS, HOMEOSTASIS AND ENERGY
ROBERT MEEKS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EDITED BY ANITA WYNN, PHD

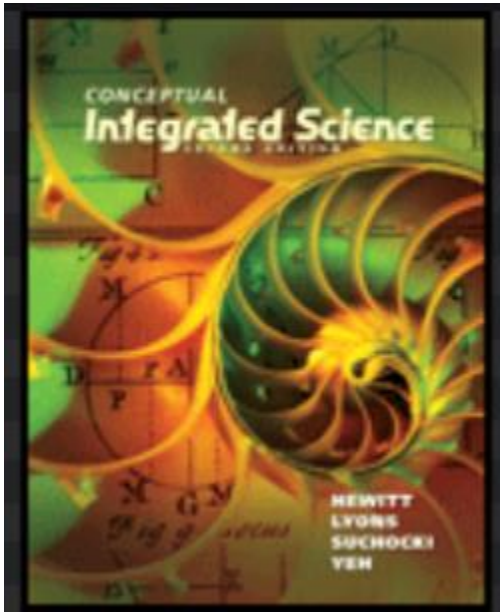
CONCEPTUAL
Integrated Science
HEWITT
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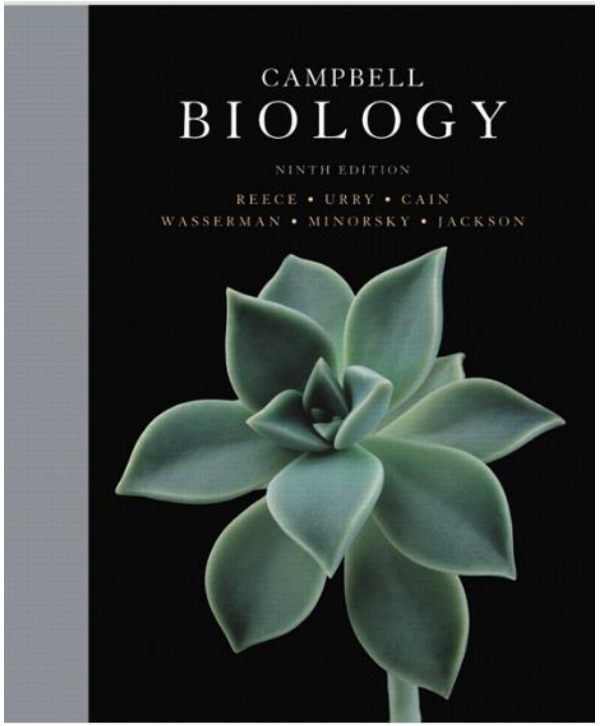
Table of Contents for *CAMPBELL BIOLOGY 9e AP* Edition* Highlighted with Concepts Included in the AP Biology Curriculum Framework



56 Chapters

Table of Contents is 16 pages

Learning Goals for This Session:

1. What, exactly, is science?

2. Processes of Science: Explore how scientific hypotheses are developed.

3. Discuss what constitutes scientific evidence (the nature and limits of science).

4. Briefly review new approaches to science education nationally and in Virginia.

5. Explore and Discuss Your Questions (as time permits)

1. What is Science?

DEFINITION OF SCIENCE
FROM THE NATIONAL ACADEMY OF SCIENCES AND INSTITUTE OF MEDICINE

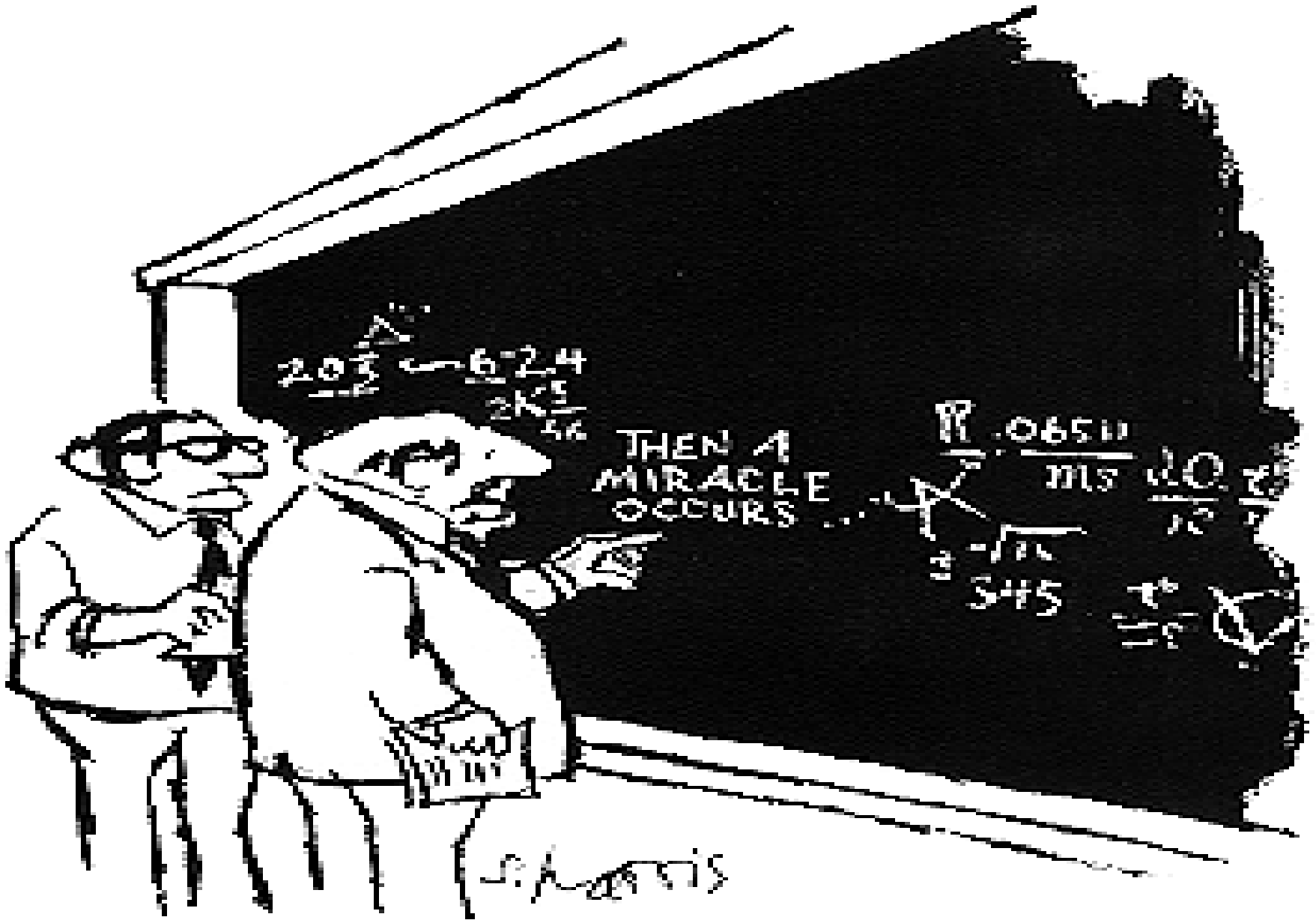
The use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.


Science is a blend of logic and imagination
Testable
Scientific ideas are durable
Tentative
Science avoids bias
The natural world is understandable
Natural
Scientific ideas are subject to change
Uncertain
Science is a social activity
Social
Observable
The Nature of Science
NATURE OF SCIENCE
vista.gmu.edu
VISTA
VIRGINIA INITIATIVE FOR SCIENCE TEACHING AND ACHIEVEMENT
vista@gmu.edu

What is Science?

What is Science?

- **Science focuses exclusively on the natural world. It does not deal with supernatural explanations.**



"I think you should be more explicit in step two"

What is Science?

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  - **how the natural world works,**
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- Accepted scientific ideas are as reliable as the quality of questions asked and the level of rigor in testing those ideas.
- As new evidence is acquired and new perspectives emerge these ideas can be, and often are revised.

Science isn't a tall stack of hard facts; it's a difficult and deeply human process that lurches toward an approximation of the truth.

Joel Achenbach
Washington Post, page A1
July 24, 2014

http://www.washingtonpost.com/national/health-science/bicep2-experiments-big-bang-controversy-highlights-challenges-for-modern-science/2014/07/23/707bc9e6-02c6-11e4-b8ff-89afd3fad6bd_story.html

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- **Science is a community endeavor.**

"Being a scientist is a special privilege: for it brings the opportunity to be creative, the passionate quest for the answers to nature's most precious secrets, and the warm friendships of many valued colleagues."
— Biochemist and neurologist Stanley B. Prusiner

Source: https://undsci.berkeley.edu/

2. Processes of Science: How Scientific Hypotheses are Developed

(Group Participation)

Glossary of Terms Used in Teaching About the Nature of Science

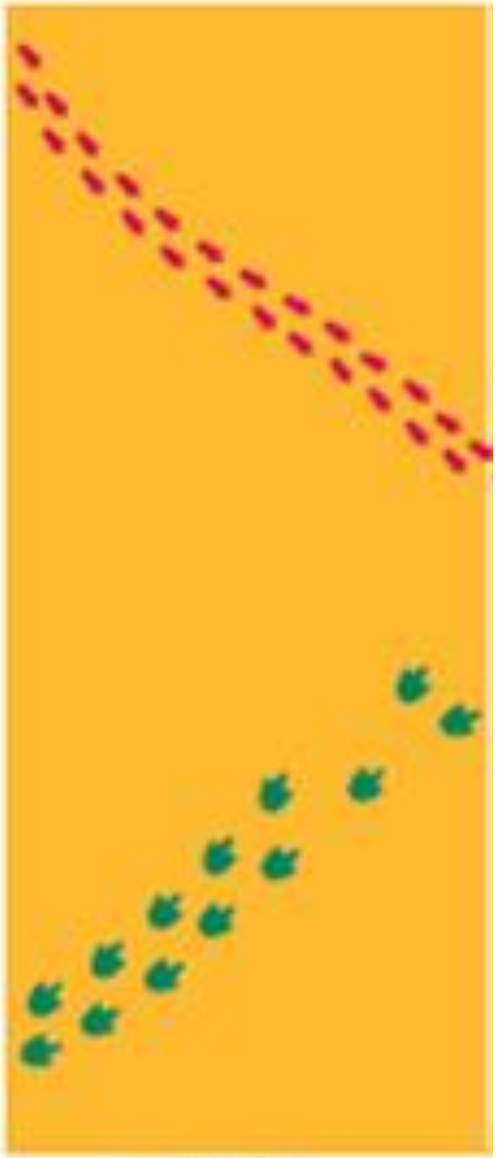
- **Fact:** In science, an observation that has been repeatedly confirmed.
- **Law:** A descriptive generalization about how some aspect of the natural world behaves under stated circumstances.
- **Hypothesis:** A testable statement about the natural world that can be used to build more complex inferences and explanations.
- **Theory:** In science, a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses.

Footprint Puzzle

Position 1

Position 2

Position 3



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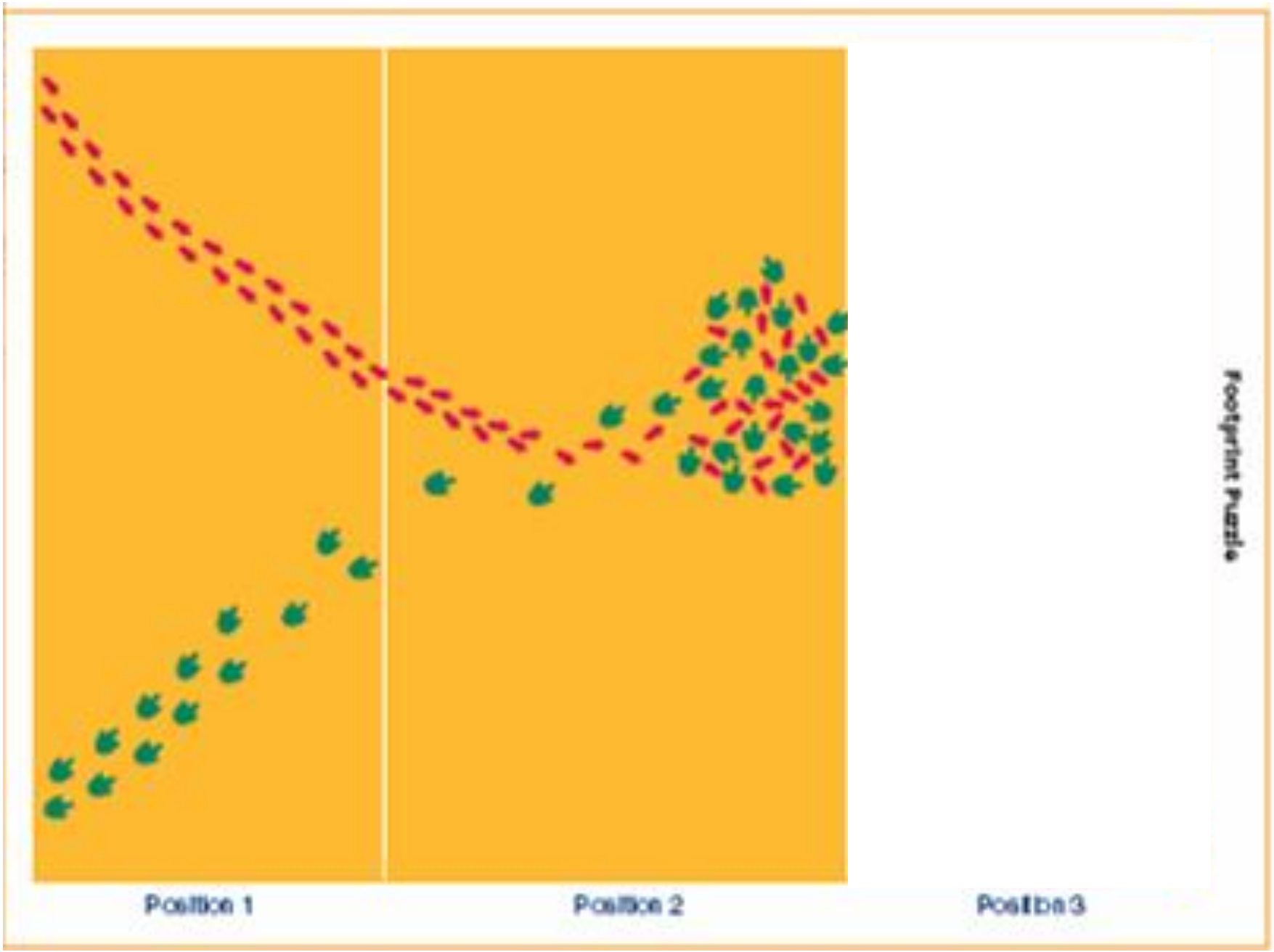
Footprint Puzzle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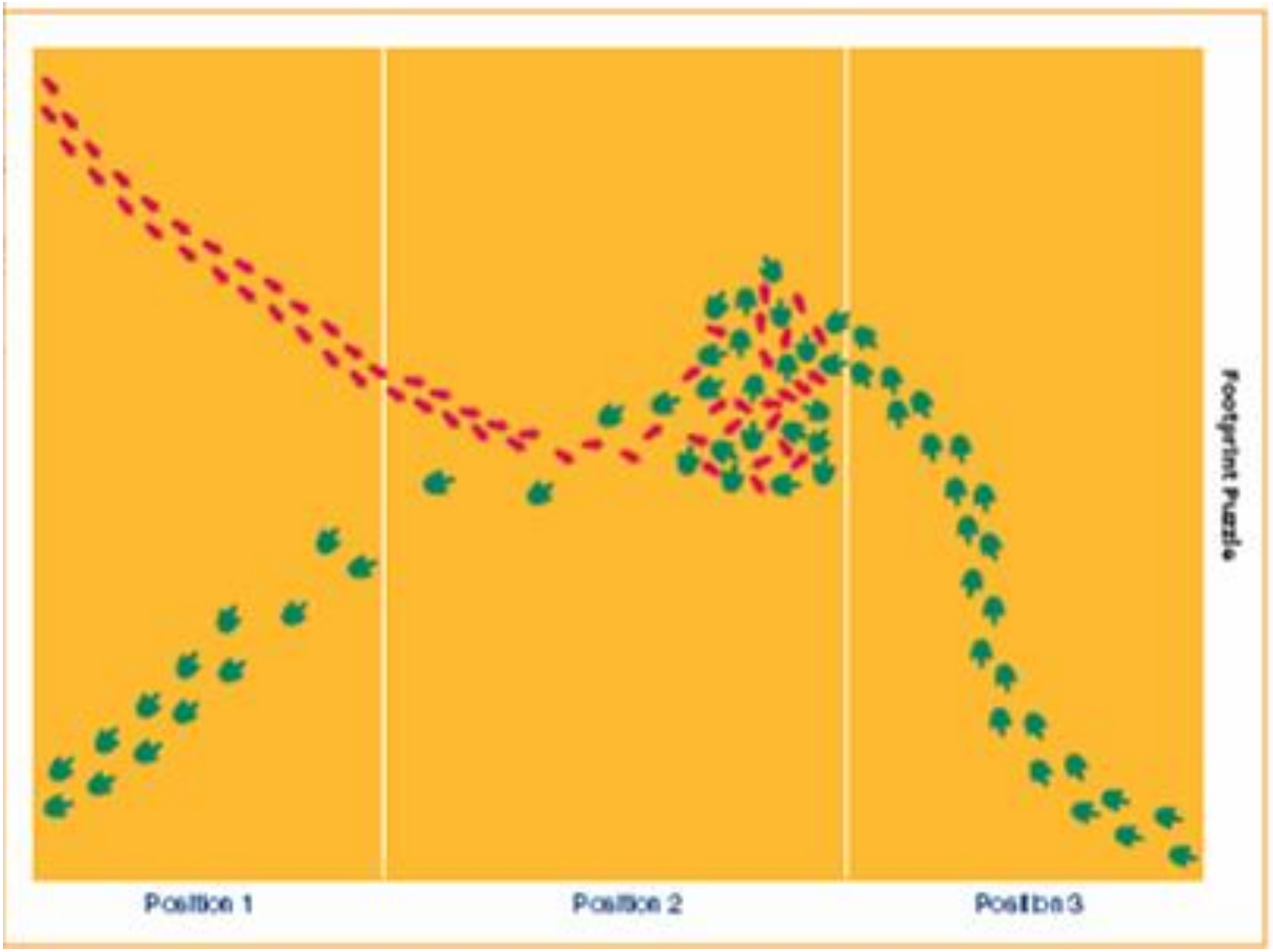
Footprint Puzzle


Position 1
Position 2
Position 3
Footprint Puzzle

3. Discuss what constitutes scientific evidence (the nature and limits of science).

Is there anything that science is incapable of investigating?

Many neuroscience issues abut against human values

- The nature of the mind
  - Mind-body-soul concepts
  - Free will vs. determinism
- The ability for anyone to look into your brain and watch your mind in action
  - Darkest secret thoughts
  - Lie detecting

More…..

Other issues are coming

- Ability to predict behaviors
- Mind-reading
- Understanding of consciousness
- Ability to treat disorders
- Ability to enhance behavioral performance
  - Moral enhancement?

All are potentially contentious

What Can't Science Do?

(Despite Our Best Efforts Sometimes to Make it Do Those Things)

- Science doesn't make moral judgments.
- Science doesn't make aesthetic judgments.
- Scientific knowledge and discoveries indicate the evidence for **what** was, is, and what may happen in the future. It doesn't tell **whether** or **how** to use that knowledge.
- Science cannot draw conclusions about supernatural explanations.

Modified from: https://undsci.berkeley.edu/article/0_0_0/whatisscience_12

Recent Medical Breakthroughs with Gene Therapy

Science

Boys with a rare muscle disease are breathing on their own, thanks to gene therapy

By Jocelyn KaiserMay. 2, 2019 , 5:20 PM

WASHINGTON, D.C.—A new gene therapy treatment has had striking results in nine boys born with myotubular myopathy (MTM), a rare disease that causes extreme muscle weakness often from birth.

The Washington Post
Democracy Dies in Darkness

Health & Science

Gene therapy cures infants suffering from 'bubble boy' immune disease

TheScientist
EXPLORING LIFE, INSPIRING INNOVATION

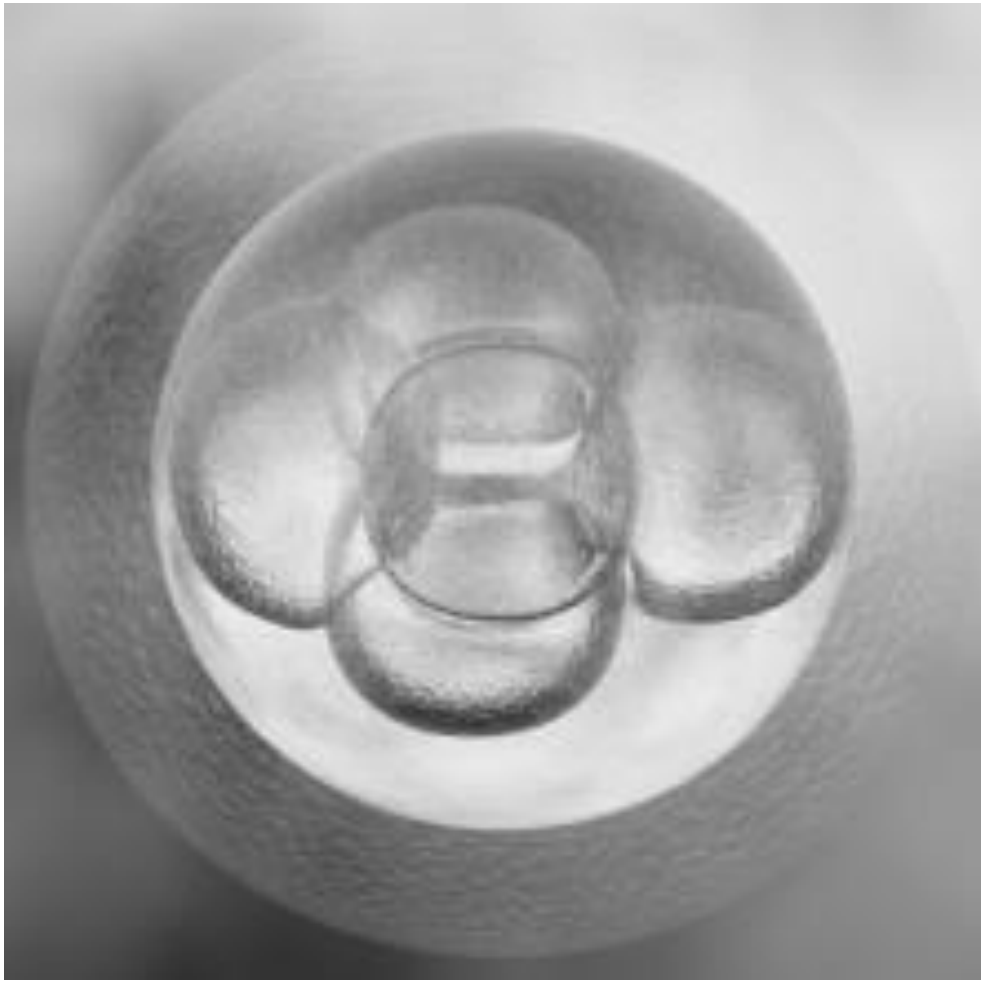
Two Patients Treated with CRISPRed Cells in Immunotherapy Trial

Shawna Williams | Apr 16, 2019

One person with multiple myeloma and one with sarcoma are the first so far to receive the genetically engineered T cells in the study.

TheScientistDaily

May 30, 2019

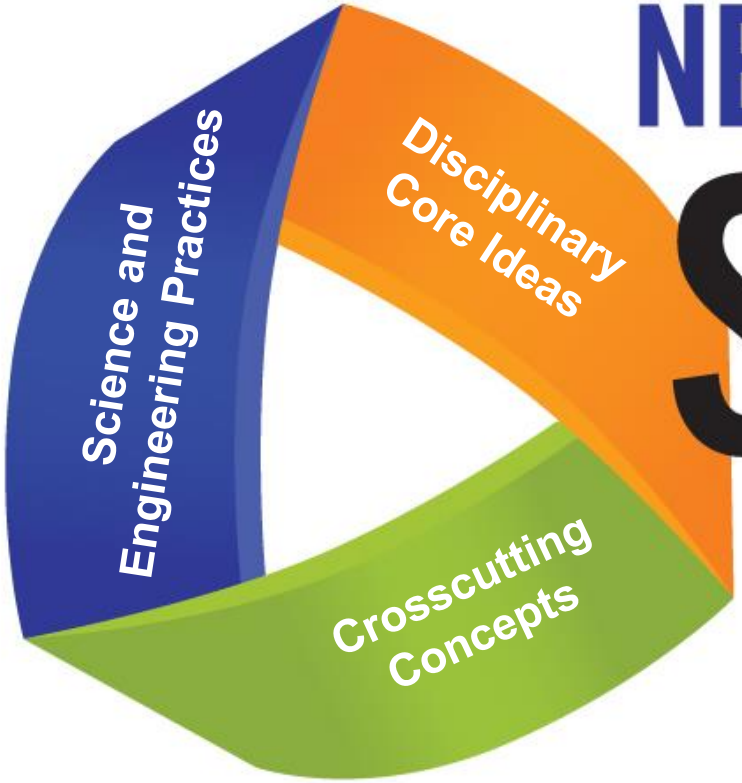


Fertility Clinics Sought Advice from Scientist Who CRISPRed Babies

By Chia-Yi Hou

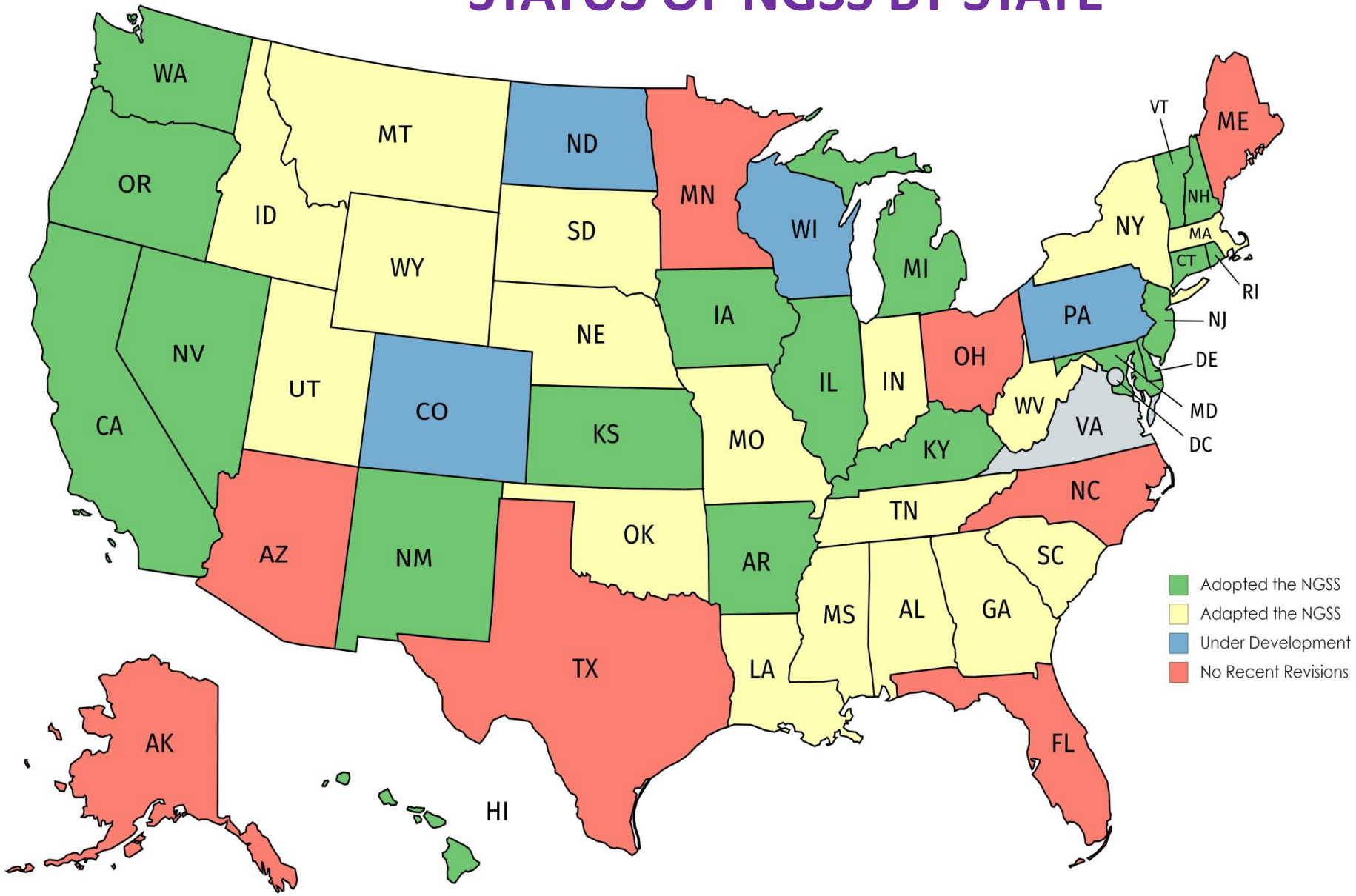
Emails reveal that a facility in Dubai and others have asked geneticist He Jiankui for help in gene-editing embryos.

4. Changing Approaches to Science Education Nationally and in Virginia



NEXT GENERATION SCIENCE STANDARDS

STATUS OF NGSS BY STATE



Dimensions of the Framework

- Science and Engineering Practice
- Crosscutting Concepts
- Disciplinary Core Ideas

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology, and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

NEXT GENERATION SCIENCE STANDARDS

Crosscutting Concepts

1. Patterns
2. Cause and effect
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change

NEXT GENERATION SCIENCE STANDARDS

Thank you!!

Questions??