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Evolving Field of Biosciences: Global Biosecurity Risks and Management Strategies

ABSA 61st Annual Biological Safety Conference, Charleston, SC
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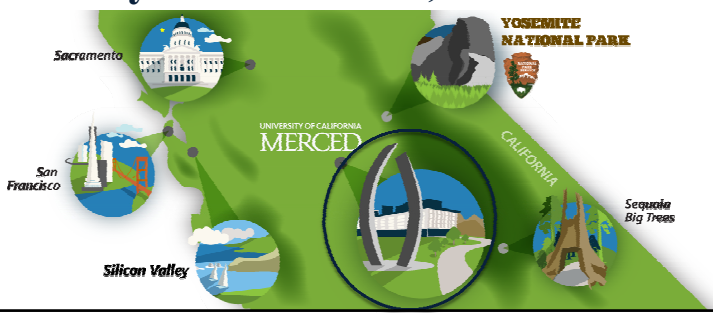
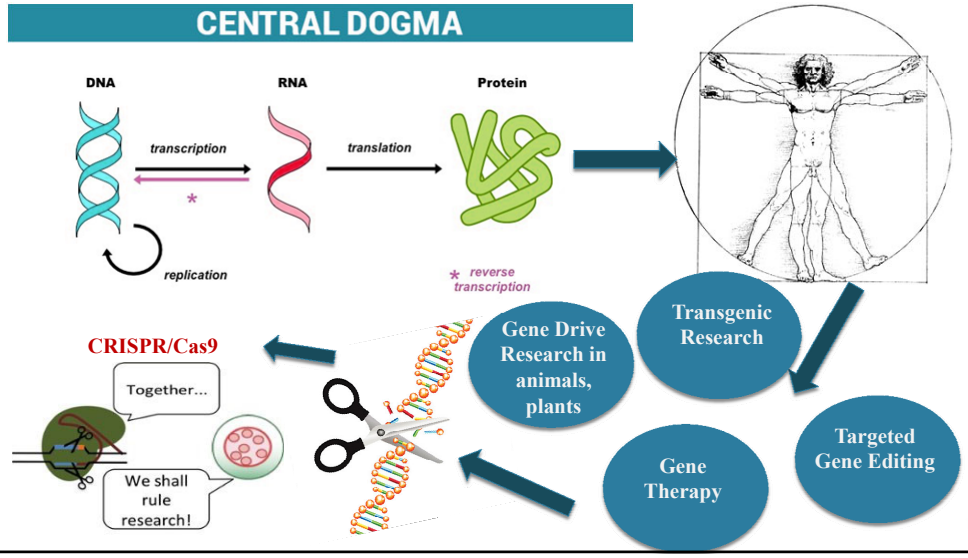
UNIVERSITY OF CALIFORNIA MERCED

- Newest and 10th campus of the Univ. of California system
- Green campus
- State of the art research labs
- **Merced 2020**- doubling the size of the campus
- **Merced 2020 Project**- High Containment Facility and Select Agent Program

University of California, Merced



Evolving Field of Biosciences!



"Re-writing the code of life"

Then why is CRIPSR/Cas9 the most talked about technology today?

Because the ease, precision, and availability of CRISPR technology is

Inexpensive powerful technology with ease of access and incomplete understanding of risks associated with it!

Modern Biological Research

MIT Technology Review

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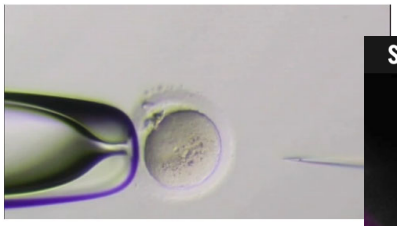
Rewriting Life

First Human Embryos Edited in U.S.

Researchers have demonstrated they can efficiently improve the DNA of human embryos.

by Steve Connor July 26, 2017

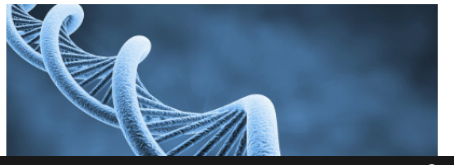


A video shows gene-editing chemicals being injected into a human egg at the mo of fertilization. Scientists used the technique to correct DNA errors present in the father's sperm.

Scientists have moved one step closer to RNA editing, which could be the next stage of CRISPR

Jonathan Shieber

@jsl September 2018



salk ABOUT SCIENCE EVENTS NEWS DONATE

March 14, 2018

CRISPR GENETIC EDITING TAKES ANOTHER BIG STEP FORWARD, TARGETING RNA

Salk scientists create new molecular scissors to correct protein imbalance in cellular model of dementia

Modern Diagnostics

NEWS

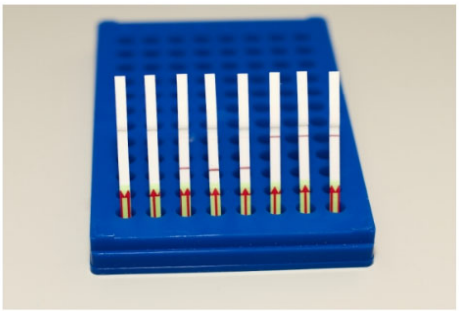
NEWS / 02.15.18

EMAIL

SHERLOCK team advances its CRISPR-based diagnostic tool

By Karen Zusi

A strip of paper can now indicate presence of pathogens, tumor DNA, or any genetic signature of interest. 100-fold greater sensitivity, the ability to detect multiple targets at once, and other new features further enhance SHERLOCK's power for detecting genetic signatures.



Credit : Zhang lab, Broad Institute of MIT and Harvard

Downside of the upcoming technology?

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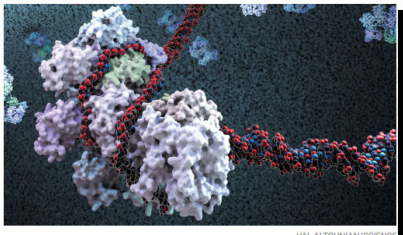


VAL ALTOUNIAN/SCIENCE

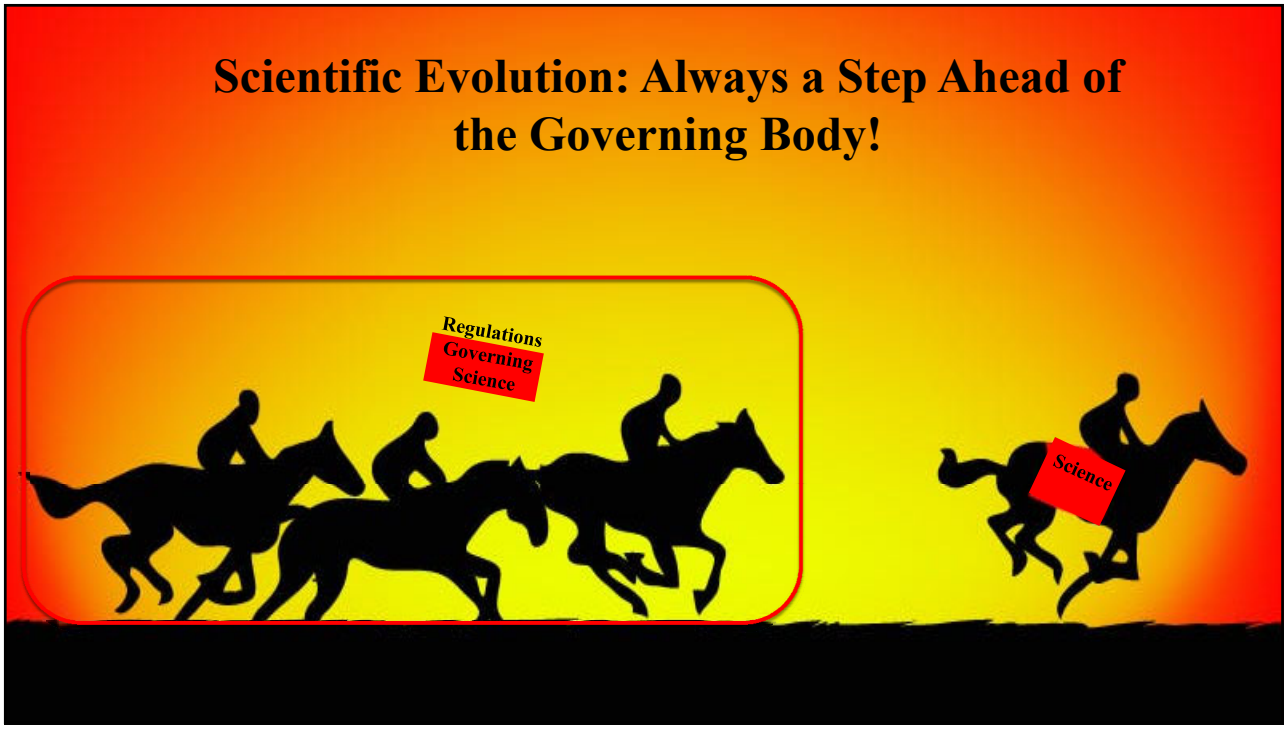
CRISPR—a weapon of mass destruction?

By Kelly Servick | Feb. 11, 2016 , 4:45 PM

Which of these threats to our existence is not like the others: North Korean nukes, Russian cruise missiles, and … the gene-editing technology CRISPR. A global threat assessment released this week by U.S. director of national intelligence James Clapper placed "genome editing" among six threats listed in the section on weapons of mass destruction. The inclusion of CRISPR and related techniques in the

U.S. director of national intelligence James Clapper placed "genome editing" among six threats listed in the section on weapons of mass destruction. The inclusion of CRISPR and related techniques in the gallery of rogues **came as a surprise** to some bioweapons experts, *MIT Technology Review* reports, though there has already been speculation that ever cheaper and more efficient editing techniques could allow terrorists to develop crop plagues or deadly viruses that shred our DNA. The American public has also registered its fears about CRISPR's potential. In a 1000-person poll released today by *STAT* and Harvard's T. H. Chan School of Public Health, **65% thought it should be illegal** to alter the genes of unborn babies to reduce the risk of serious diseases, and 83% opposed such editing to improve "intelligence or physical characteristics."

Scientific Evolution: Always a Step Ahead of the Governing Body!



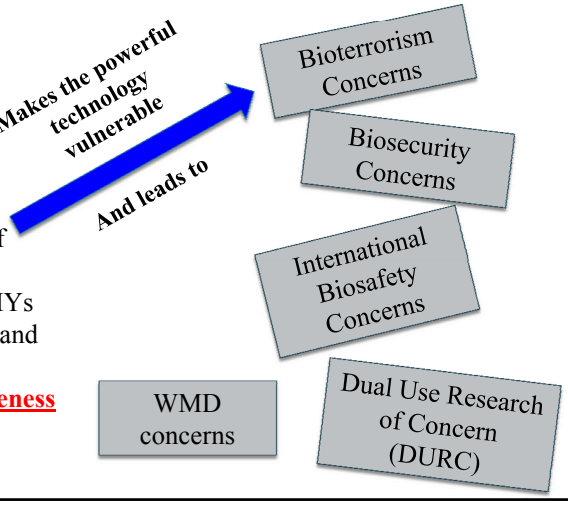
Gene Editing and Molecular Tools: Enhancing the quality of life!

- Global food security
- Enhancement of food quality
- Targeted Gene Therapy
- Gene Drive- targeted gene editing (CRISPR) for eradication of malaria, etc.
- Cure for infectious diseases: viral, bacterial

If quality of life is enhanced then why the "brows are furrowed"??

'Science cannot continue in vacuum'

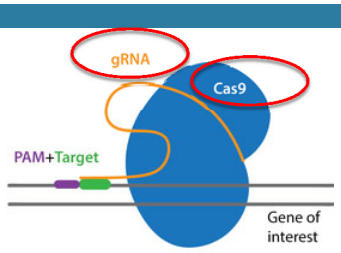
- Spread of "Know-Hows"
- Easy availability of the technology
- New technical possibilities such as "synthetic oligonucleotide" sequence-mimicking gene sequence of infectious pathogens
- Science democratization: DIYs
- Open accessible publication and open sources of knowledge
- **Limited training and awareness**



Reviewing the Basics: Molecular Biology 101

- Vector System (Plasmid vs. Viral Vector)
- Gene Target
- Host System
- Indigenous or Exotic

Reviewing the basics: CRISPR 101

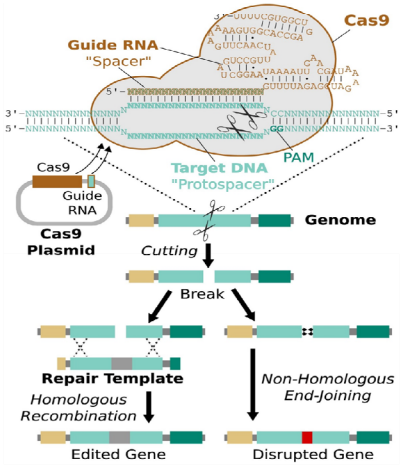


Genome Engineering
Transcriptional Regulation
Other Applications

CRISPR can knock out target genes in various cell types and organisms modifications to various Cas enzymes have extended CRISPR to selectively activate/repress target genes, purify specific regions of DNA, image DNA in live cells, and precisely edit DNA and RNA.

https://www.addgene.org/genome-engineering/

The CRISPR Mechanism



Gene Editing and Emerging technologies

Primary questions to ask when assessing risks:

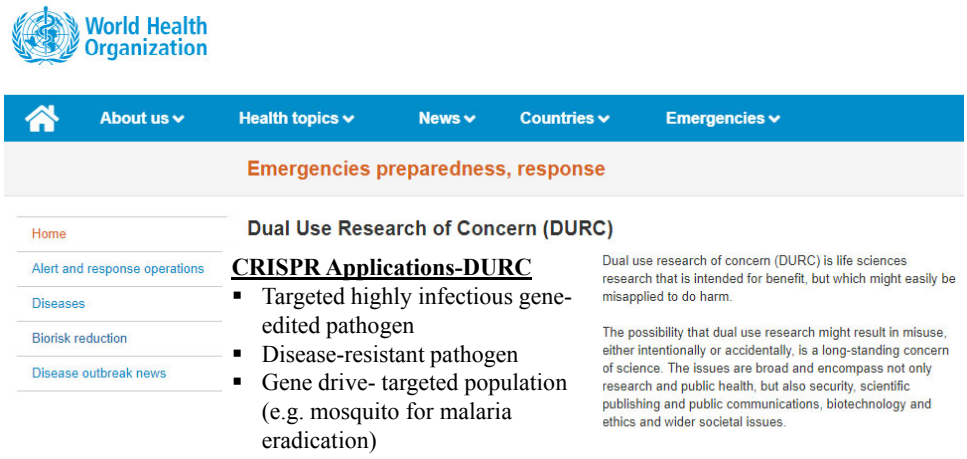
- Off-targeting effects?
- Delivery system used?
- Permanent/ heritable modification?
- Multiple genes being targeted in one construct/ technology?
- Potential risks to personnel for exposure to material or the resulting modified organism?
- Researcher Experience/ Knowledge

Gene Editing and Emerging technologies

Recommendations and Feedback to the Principal Investigator (PI)

- Biosafety Practice Level
- Record Maintenance
- Training Required
- Regular Audits
- Hands-on Training (if required)

Emerging Technologies, DURC and International Biosecurity Challenges



International Biosafety-Biosecurity Challenges

- Poorly understood challenges
- Lack of Training and human resource development
- Lack of expertise in risk assessment and decision making
- Lack of international regulatory compliance and poor biosecurity planning
- Unanticipated or unintended complication avoidance

Regulations: Governance and Monitoring

Unites States

Regulations: Governance and Monitoring

Mexico

- World Trade Organization (WTO)
- Food and Agriculture Organisation of the United Nations (FAO)
- International Plant Protection Convention (IPCC)
- Office International des Epizooties (IOE)/World Animal Health Organisation

Globalization of Science and International Partnerships

International ethical standards and guidelines brings strong partnerships and better

- Cross-border research biosafety/security standards
- International engagement
- Thorough understanding of emerging technologies
- Every experiment is different- Every Clinical and Agricultural trial has different risk

Remember: Powerful synthetic biotechnological innovations such as CRISPR/Cas9 and pathogens do NOT need 'homeland security' and 'border clearances'!

The Latest in Public Health!

- ❑ International Surveillance
- ❑ Prevention vs. Response Strategies
- ❑ Risk Assessment and Preparedness

Globalization of Science and Challenges

- ❑ Resource Limitation
- ❑ Lack of Understanding of Risks-Emerging Technology Use
- ❑ Lack of Preparedness-Infectious Disease Research and Outbreak
- ❑ International Governance- Uniform Regulations
- ❑ Human Resource Development and Communication

"Bringing science closer to life"

Communicating the science behind technology openly, honestly!

- Awareness brings proactiveness in society
- Ethical concerns must be addressed
- Informed decision making reduces panic and distress in society

Many developing countries still do NOT completely understand the adversities associated with misuse of powerful synthetic biotechnology such as CRISPR- **intentionally or accidentally**!

Remember: "Good Science" always comes with ethics, compliance, and honest communication!

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Thank you!

- UC Merced Leadership & EH&S Team
- Luis Alberto Ochoa Carrera, Mexico
- ABSA International Scientific Program Committee
- You all!

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