
Science Circle
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Contract Research Scientist
Pioneer Dupont
New Advances in Genetic Engineering

Background
DNA, Bacterial Immunology

CRISPER/Cas9 Applications
Disease, Agriculture, Pest Management

Future Possibilities and Ethics
Moral Dilemmas of Human Enhancement
DNA Structure
DNA Structure

Hybridization
Hybridization—from a chemistry perspective, a stretch of DNA can find and bind to its complementary sequence.
Hybridization—it doesn’t have to be a perfect match "off-target"
DNA Technologies
Chromosome Painting
The Nobel Prize in Chemistry 1993 was awarded “for contributions to the developments of methods within DNA-based chemistry” jointly with one half to Kary B. Mullis “for his invention of the polymerase chain reaction (PCR) method” and with one half to Michael Smith “for his fundamental contributions to the establishment of oligonucleotide-based, site-directed mutagenesis and its development for protein studies”.

Kary B. Mullis
Prize share: 1/2

Michael Smith
Prize share: 1/2
DNA Technologies

PCR

The Nobel Prize in Chemistry 1993

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Forensics
Paternity
Evolutionary Biology
Anthropology
DNA Technologies

RNAi

The Nobel Prize in Physiology or Medicine 2006

The Nobel Prize in Physiology or Medicine 2006 was awarded jointly to Andrew Z. Fire and Craig C. Mello “for their discovery of RNA interference - gene silencing by double-stranded RNA.”
DNA Technologies
Detection, Amplification, Gene Silencing
But not Precise Manipulation
Human Immune System

“Memory” within one’s lifetime
Bacterial Immune System

Fig. 2 Biology of the type II-A CRISPR-Cas system. The type II-A system from *S. pyogenes* is shown as an example.

Jennifer A. Doudna, and Emmanuelle Charpentier Science 2014;346:1258096
Fig. 5 Cas9 can be programmed using a single engineered RNA molecule combining tracrRNA and crRNA features.

Martin Jinek et al. Science 2012;337:816-821
CRISPR/Cas9 System

Jennifer A. Doudna, and Emmanuelle Charpentier Science 2014;346:1258096
Genome Editing Examples

AIDS
Cancer
Drought Resistance
Inhibition of HIV-1 infection of primary CD4+ T-cells by gene editing of CCR5 using adenovirus-delivered CRISPR/Cas9


--in the absence of CCR5, HIV cannot enter CD4+ B cells
Genome Editing Examples

The CRISPR/Cas9 system inactivates latent HIV-1 proviral DNA

Retrovirology 2015, 12:22
ARGOS8 variants generated by CRISPR-Cas9 improve maize grain yield under field drought stress conditions

Plant Biotechnology Journal (2016), pp. 1–10
Inactivation of the Human Papillomavirus E6 or E7 Gene in Cervical Carcinoma Cells by Using a Bacterial CRISPR/Cas RNA-Guided Endonuclease

J. Virol. October 2014 vol. 88 no. 20 11965-11972
A CRISPR-Cas9 gene drive system targeting female reproduction in the malaria mosquito vector *Anopheles gambiae*

*Nature Biotechnology: 7 December 2015*

---sterility gene
Future Directions

Human Germline editing
- are we content with just treating diseases after they manifest?

- is it not a moral obligation to avoid trauma and suffering before it begins?
Future Directions

Human Germline editing
- Do we understand the implications in all situations of all genetic “defects?”

Cystic Fibrosis
Sickle Cell Anemia have selective advantages when heterozygous
Future Directions

[Image of a movie poster for "Gattaca"]