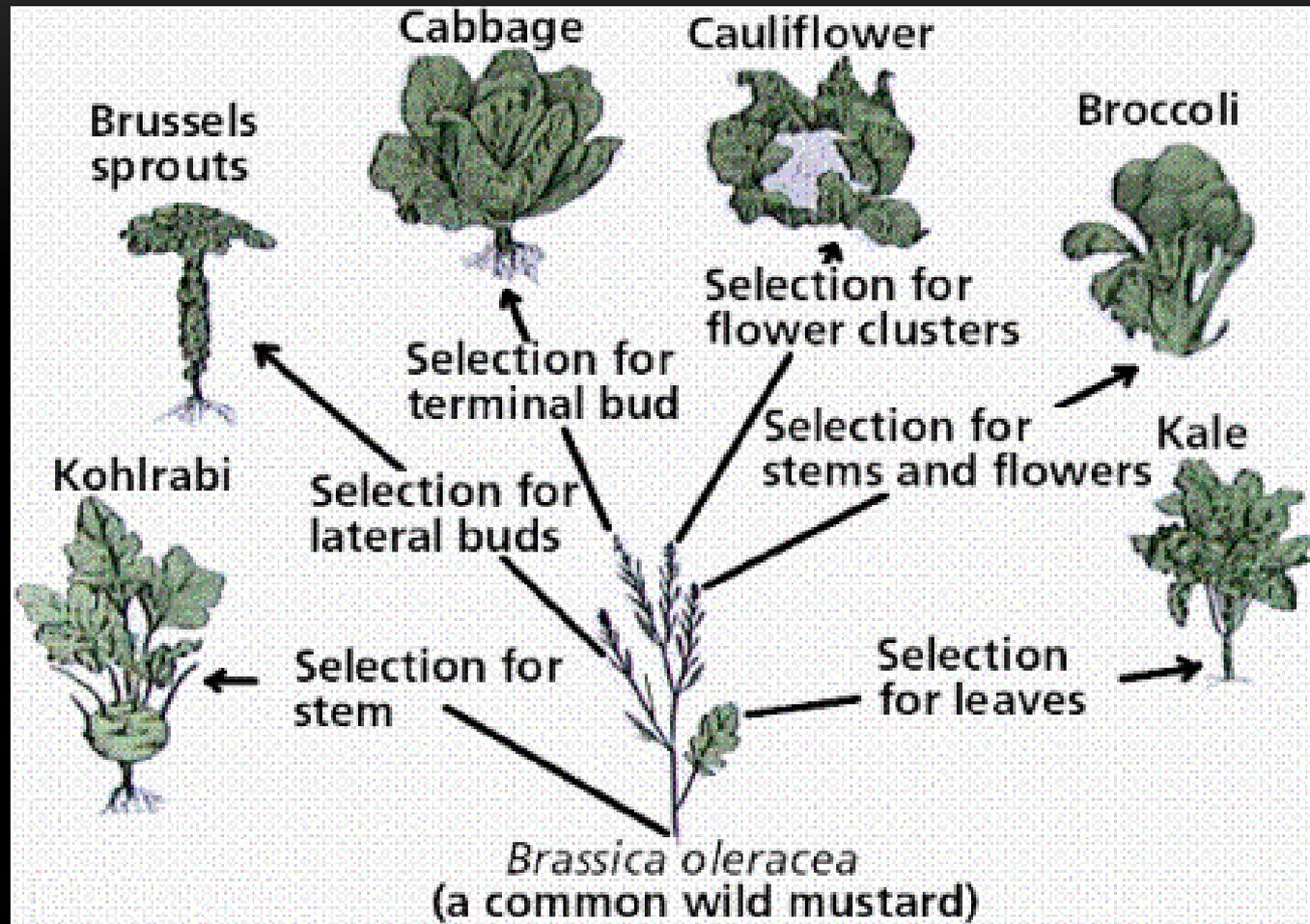


SCIENCE IN SOCIETY - GM

Dr Cherryl Hunt, University of Exeter

Christians in Science Student Conference, Birmingham, February 2016

GENETIC MODIFICATION BY BREEDING



GENETIC MODIFICATION BY MANIPULATION

Rather than just breeding new combinations of genes:

- Deleting / replacing / inserting genes = gene editing
 - + Genes from different species or synthetic genes:
 - microbes
 - plants
 - animals
 - humans
-

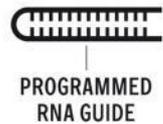
AN ASIDE: CRISPR

- It's potentially going to change just about living thing. So, it's going to start with the food on our plate, it's going to be the pets at our feet, the plants in our garden, even the mosquitoes whining in your ear at night. Eventually, it's going to be the cells in your body, and, of course, most controversially, perhaps even the brains and bodies of our children are going to be changed by this technology.

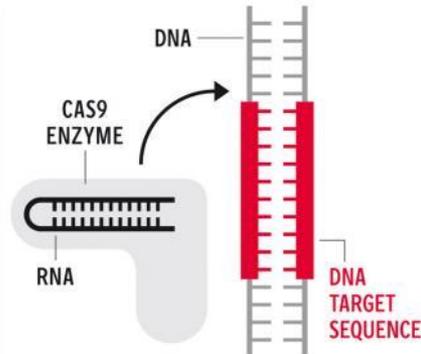
- Michael Le Page

A BRAVE NEW WORLD OF GENOME EDITING

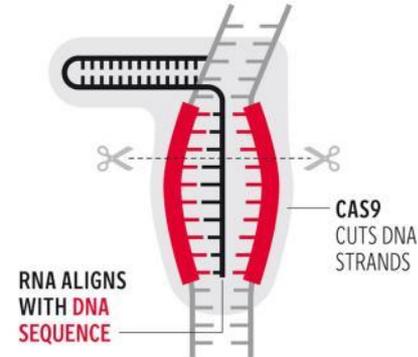
How the Crispr system derived from bacteria works on human cells to correct genetic defects



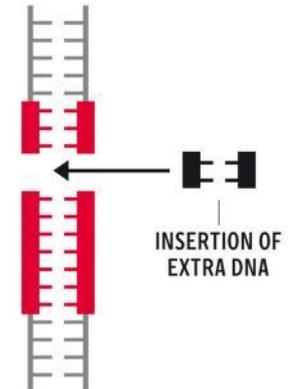
1 An RNA “guide” molecule can be **programmed to match any unique DNA sequence** found in the human genome



2 A special enzyme, called **CAS9**, can be **attached to the RNA guide**. Its job is to find the target sequence of DNA



3 The RNA aligns with the target DNA sequence and the **CAS9 attaches and cuts both strands of the DNA double helix**



4 The DNA cuts can be **amended with an extra DNA insertion** (above), or a deletion of defective DNA

SOURCE: UC BERKELEY

<http://www.independent.co.uk/news/science/exclusive-jaw-dropping-breakthrough-hailed-as-landmark-in-fight-against-hereditary-diseases-as-8925295.html>

AN ASIDE: CRISPR

- Uses a bacterial defence mechanism
- Can target very specific stretches of the DNA sequence
- Allows deletion and/or insertion of sequences
- Has some degree of error but less than earlier techniques of gene splicing
 - Poses no really new ethical issues but sharpens debate as it makes it more likely that some techniques will be used

GENETIC MODIFICATION & SYNTHETIC BIOLOGY

- Genetically Engineered Microorganisms (GEMs)
 - Experimentally as lab organisms, medicinal
 - Industrially, as 'manufactories' of commercial products: chemicals, medicines etc
 - Potentially (?) as weapons
 - Social justice – replacement of traditional origin
 - Ecological concerns – 'escapes'
-

GENETIC MODIFICATION

- Plants
 - To enhance growth in difficult environments
 - To enable use of pesticides
 - To improve nutritional value
 - biopharming
- Social justice – corporate control and ‘property’
- Ecological concerns, gene transfer e.g. resistance

GENETIC MODIFICATION

- Animals
 - to promote human health (disease models & organs for xenotransplantation)
 - To improve food yield
 - Biopharming 'manufactories'
 - Social justice – GM organisms as 'property'
 - Ecological concerns and animal rights
-

GENETIC MODIFICATION

- Of humans
 - Experimentally: HFEA 14 day limit
 - Therapeutically
 - Somatic gene therapy, current
 - Therapy affecting germ-line, illegal in UK
- Status and protection due to early human life?
- Social justice: genetic underclass?

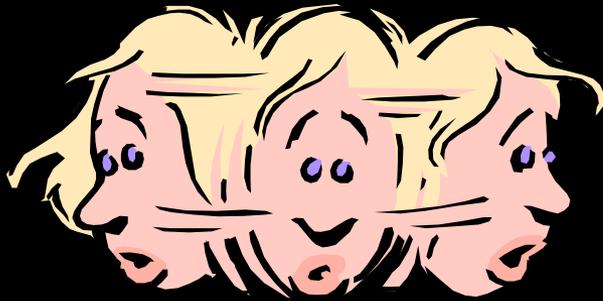
GENETIC MODIFICATION

- Of humans
 - Reprogen - genetically affect physical and/or mental attributes by prenatal genetic enhancement (PGE)? Inevitable?
 - Somatic
 - affecting germ-line, illegal in UK
- Social justice: genetic underclass?
- Issues of humanity – what is it to be human?

CLONING AND HUMAN ADMIXED EMBRYOS

- cybrids (cytoplasmic hybrid)s
- chimaeras
- human transgenic embryos
- true hybrids
- What limits, if any, should there be on putting human genetic material into animals grown to term: when does such an entity = a human being?

ETHICAL STRATEGIES



*Answers to
the question:
What should I
do?*

ETHICAL STRATEGIES

- **UTILITARIAN**
 - Greatest 'good' for greatest number
 - 'the ends justify the means'
 - Jeremy Bentham & John Stuart Mills
 - **DEONTOLOGICAL**
 - Imperatives
 - 'Let justice be done though the heavens fall.'
 - Immanuel Kant
-

SOME CHRISTIAN RESPONSES – UTILITARIAN

- Warning against possible bad effects:
 - on ecology
 - Danger of viruses/genes jumping species
 - Deleterious effects on societal structure
 - Attitudes towards disability
 - Unpredictability of genetic changes in individuals



CHRISTIAN RESPONSES – DEONTOLOGICAL 1

- Biblical texts
 - Search for relevant passages; ‘proof texts’
 - Gen 1.26 *imago dei*
 - Passages urging social justice

CHRISTIAN RESPONSES – DEONTOLOGICAL 2

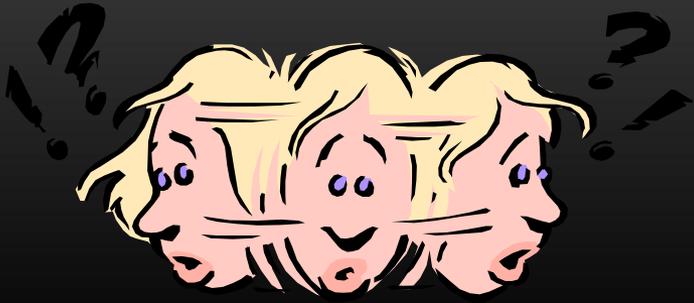
- Biblical texts
 - Lev 19.19 You shall not let your animals breed with a different kind; you shall not sow your field with two kinds of seed; ...
 - ... nor shall you put on a garment made of two different materials

CHRISTIAN RESPONSES – DEONTOLOGICAL 3

- Appeal to principles within traditional Christian teaching
 - Difficult when topic under consideration is completely novel
 - Complicated by human (religious?) tendency to have aversion to novelty
 - No clear cut principles to follow.
-

ETHICAL STRATEGIES

- **VIRTUE ETHICS**
 - Emphasis on who you are > what you do
 - Moral character
 - How would a virtuous person act?
 - Habit rather than action
-



Virtue ethics.

*The questions
should be:*

What am I like?

How do I get there?

*What kind of
person should I be?*

CHRISTIAN VIRTUE ETHICS

- Characteristics considered virtuous may vary with culture
 - Aristotle & Aquinas. Christian virtues for today?
 - Love of neighbour as yourself? (Lev 19.18; Matt 22.38//Mark 12.31; Rom 13.10)
 - Justice?
-

CHRISTIAN RESPONSES – VIRTUE ETHICS

- Example from Christian reflection on personhood and other areas of bioethical concern – Neil Messer 2011 *Respecting life: Theology and Bioethics* (London: SCM)
 1. Conform us to the image of God or try to be ‘like God’?
 2. Attitude to material world?
 3. Attitude towards neighbour?
 4. Good news to the poor?
 5. Attitude towards past failures - humility

CONCLUSIONS

- GM's potential to improve food production and contribute to human health
 - Dangers of ecological and health accidents with GM
 - GM's potential mis-use to exacerbate the gulf between rich elite and poor, in conditions and in human welfare
 - Christian reflection on - and participation in - GM should be shaped by love of neighbour and informed by realistic estimation of the outcomes
-