Chapter 7
Agricultural Biotechnology

Outline:

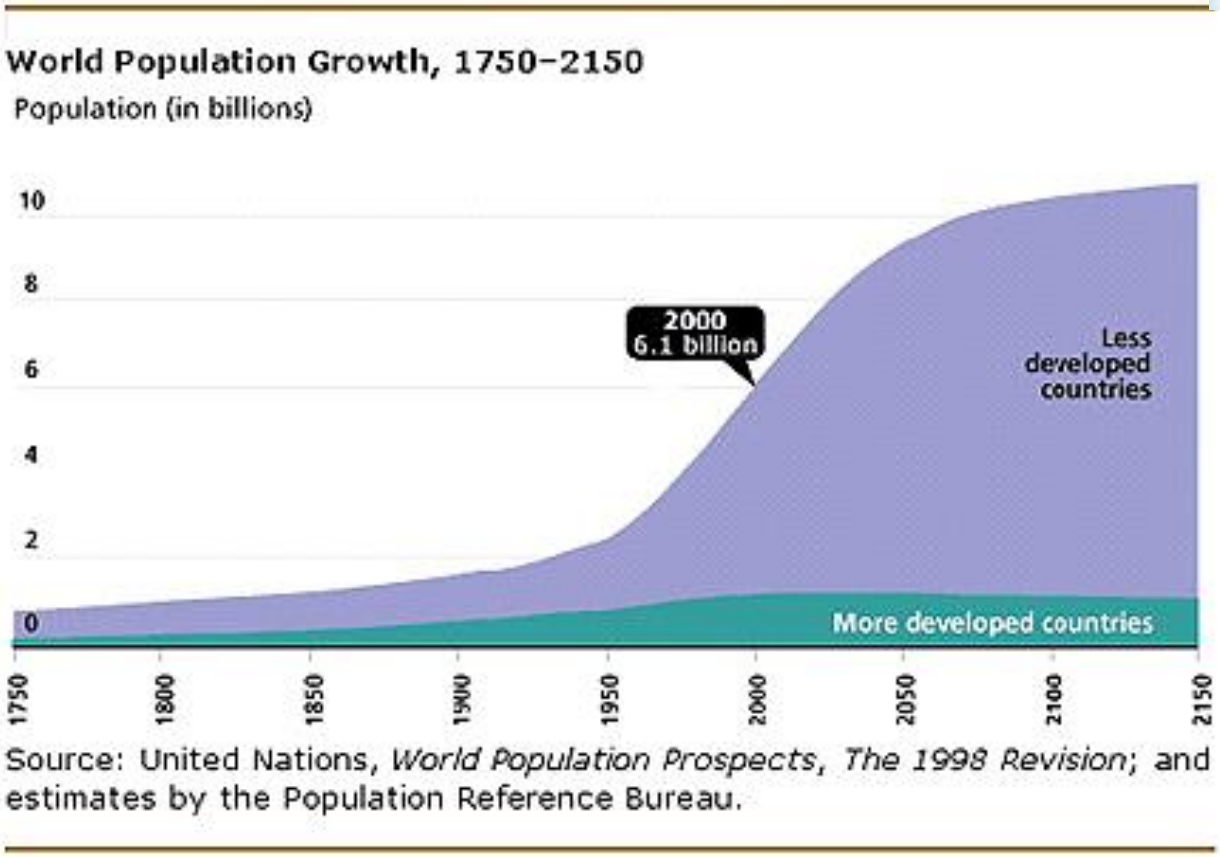
- 7.1 Introduction
- 7.2 Plant tissue culture
- 7.3 Genetically Modified Plant
- 7.4 Animal cloning
- 7.5 Genetically modified animal

Learning outcomes:

- Describe the steps in plant tissue culture.
- Describe the steps of genetic engineering in plant.
- Distinguish *Agrobacterium tumefaciens* and Gene gun/Biolistic bombardment system for the transformation of plant.
- Distinguish animal cloning and genetically engineered animal.
- Describe the methods for the creation of a transgenic animal.

7.1 Introduction

- Increase of world population

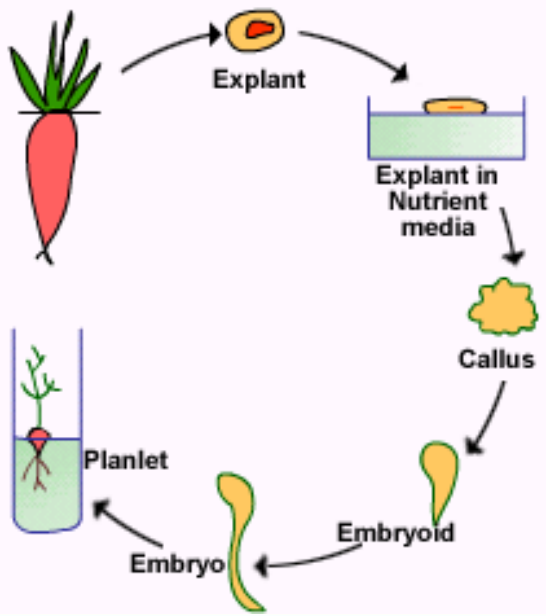


7.1 Introduction

- Food security
- Selective breeding VS Agricultural biotechnology

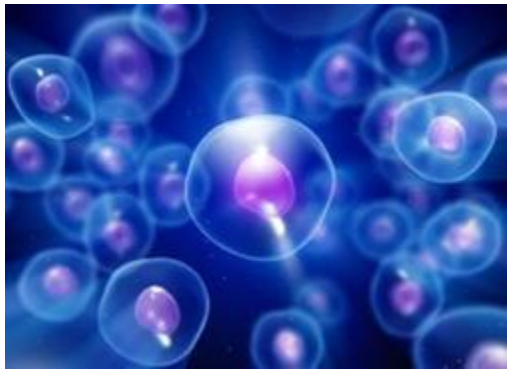
7.2 Plant tissue culture

- Totipotency:
  - ability of a cell or tissue or organ to grow and develop into a fully differentiated organism.
  - An entire plant can be regenerated from a single cell.



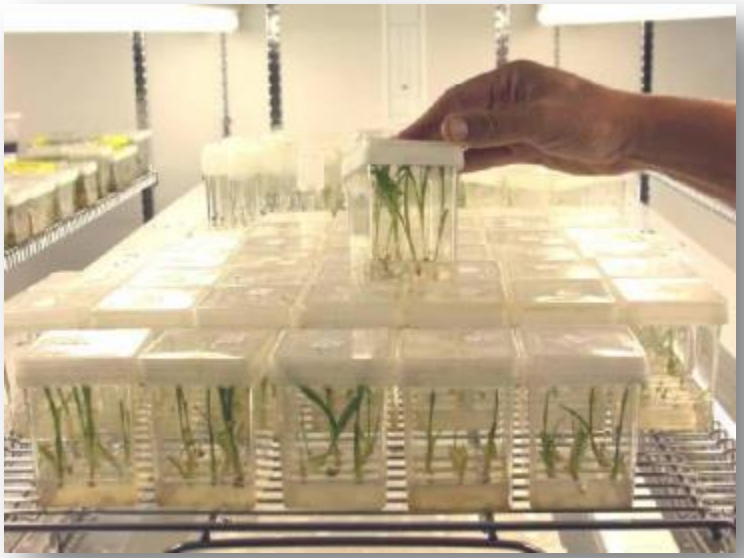
Discussion

- Is totipoteny found in human/animal?



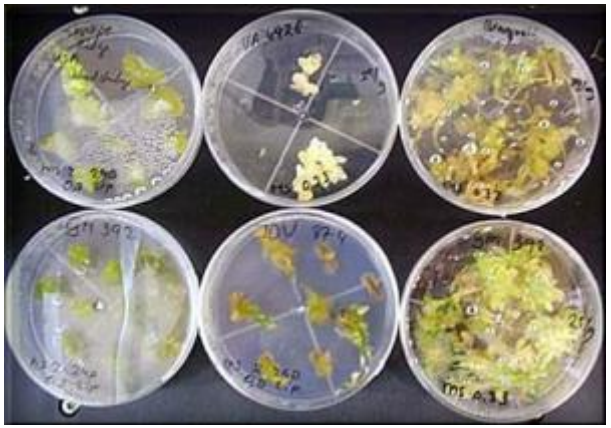
7.2 Plant tissue culture

- Plant tissue culture:
  - A process of growing a plant in the laboratory from cells rather than seeds.
  - Also called micropropagation.



7.2 Plant tissue culture

- callus culture- solid medium
- suspension culture- liquid medium.



7.2 Plant tissue culture

a mass of tissue or cells (explant) must be removed from the plant of interest

undifferentiated cells form a crystalline white layer on top of the solid medium, called the callus

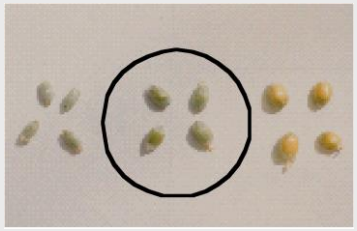
undifferentiated callus cells to develop into a plant shoot

root hairs to start growing from some of the shoots

plantlet

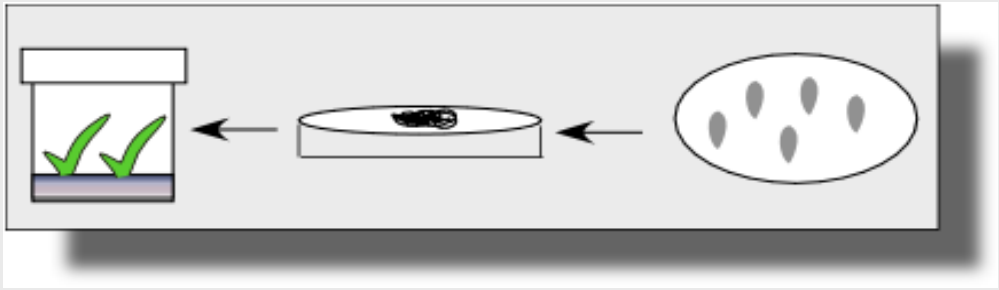
Tissue Culture:

Wheat inflorescence



seeds

embryos



- auxin/ + cytokinin

Callus

+ auxin

Discussion

- What is the advantages of plant tissue culture?

The advantages

- To produce many copies of the same plants
- To produce plants anytime we want although the climates are not appropriate to produce a plant. Moreover, if seed is not available, it is possible to produce a plant with this method.
- If there is plant with partially infected tissue, it is possible to produce new plant without infection.

The advantages

- Very helpful in the genetically modified organism studies.
- Very useful solution for the prevention of starvation in third world countries since the process id highly efficient
- The time required is shortened, no need to wait for the whole life cycle of seed development.

7.3 Genetically Modified Plant

- Genetic engineering in plant: enabling directed changes to be made to the genotype of a plant, circumventing the random processes inherent in conventional breeding
- GM plant/crop : plants with the DNA that has been modified using genetic engineering techniques

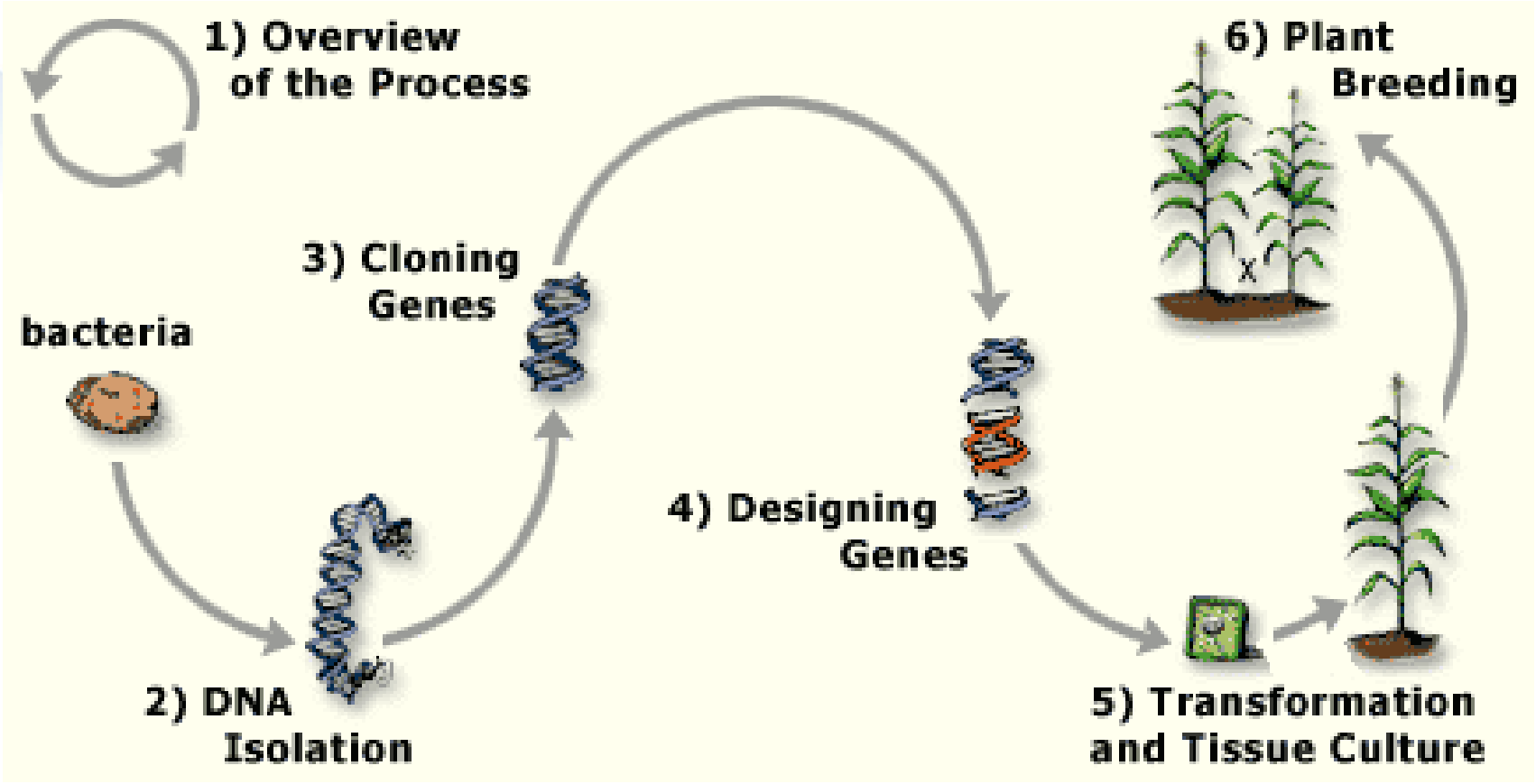
7.3 Genetically Modified Plant

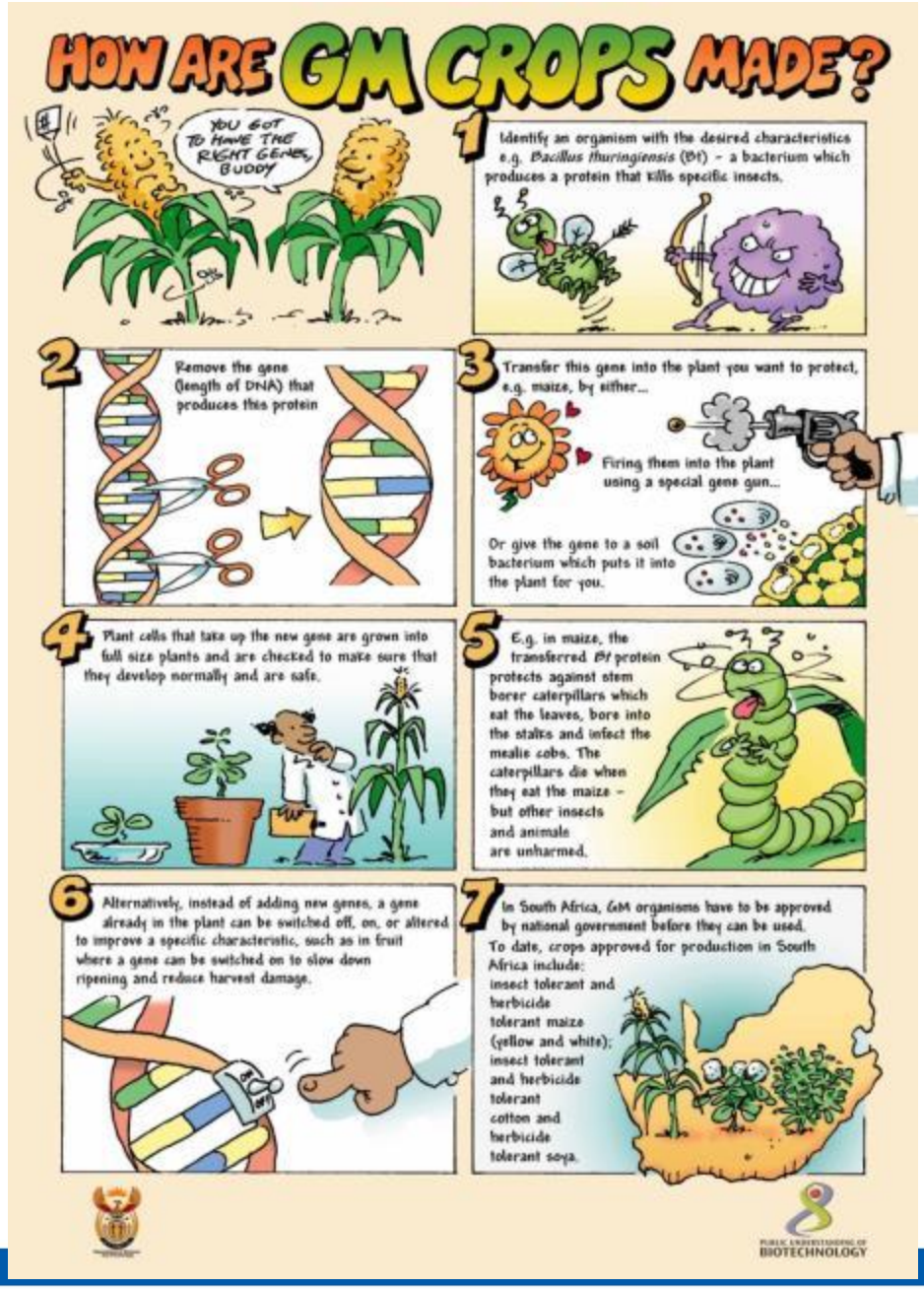
There are five major steps involved in GM plant:

1. DNA is extracted from an organism that has the desired trait.
2. The desired gene is located and copied.
3. The gene is inserted into a single plant cell using a transformation method.
4. The cell multiplies and grows a new plant that contains the transgene in all of its cells.
5. Through backcross breeding the transgenic plant is crossed with a plant from a high yielding line. The resulting hybrids are the genetically modified plants that can enter the marketplace.

http://www.instruction.greenriver.edu/mcvay/ES204/ES%20docs/animations/transgenic_plants.swf

7.3 Genetically Modified Plant

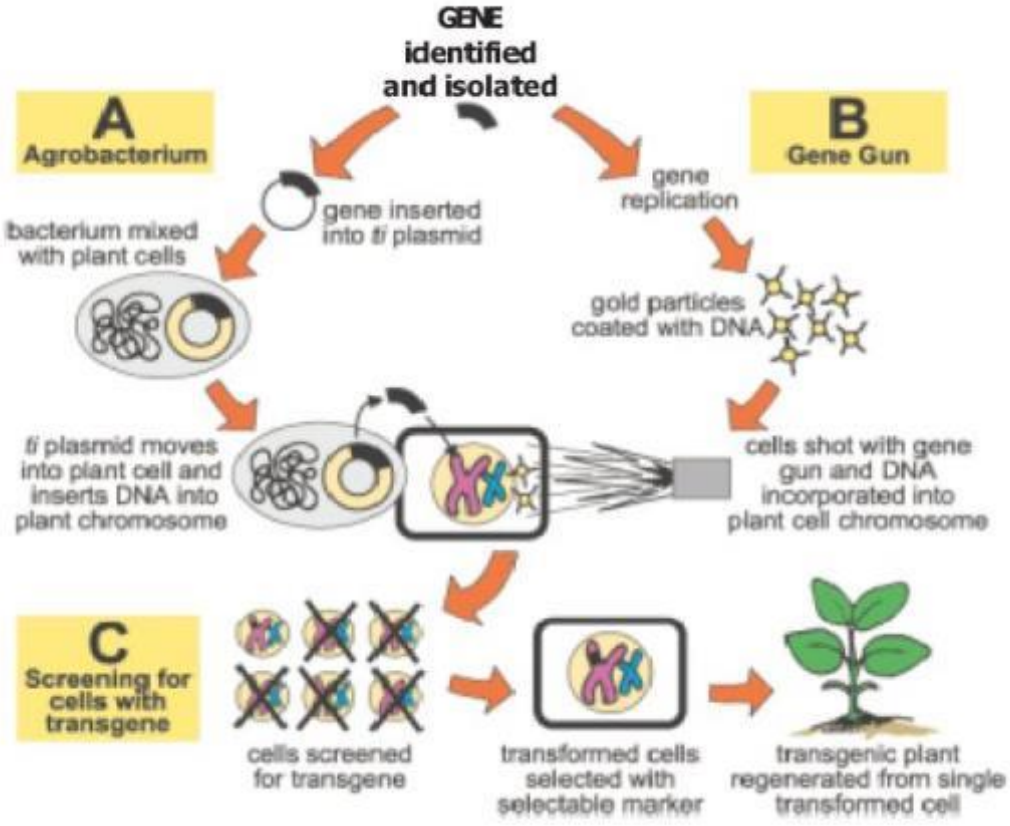




http://www.pub.ac.za/resources/docs/cartoon_gm_crops.pdf

7.3 Genetically Modified Plant

- Transformation of foreign DNA into plant:
  - ***Agrobacterium tumefaciens***
  - **Gene gun/Biolistic bombardment system**

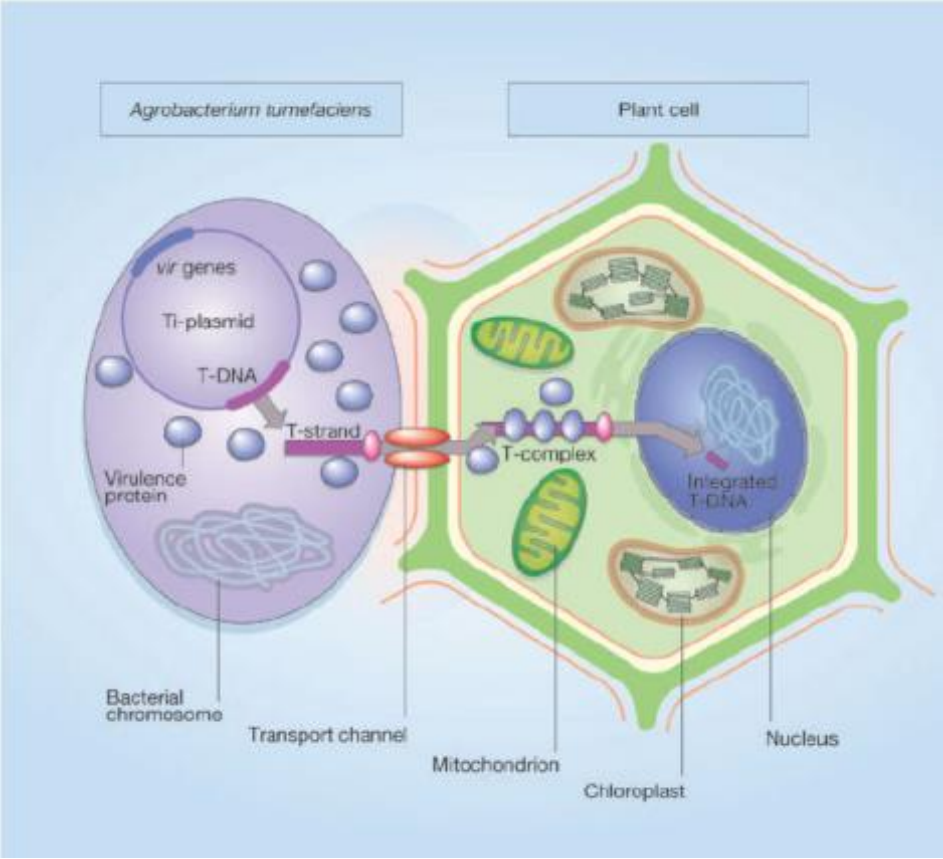


7.3 Genetically Modified Plant

- ***Agrobacterium tumefaciens***
- **A soil bacterium that Crown Gall disease**
- **During the infection, a specific segment of the Ti plasmid DNA (T-DNA- responsible for tumour formation) is transferred from the bacteria to the plant.**
- **Scientists have exploited this genetic transfer in order to get genes with desired properties into plant cells.**

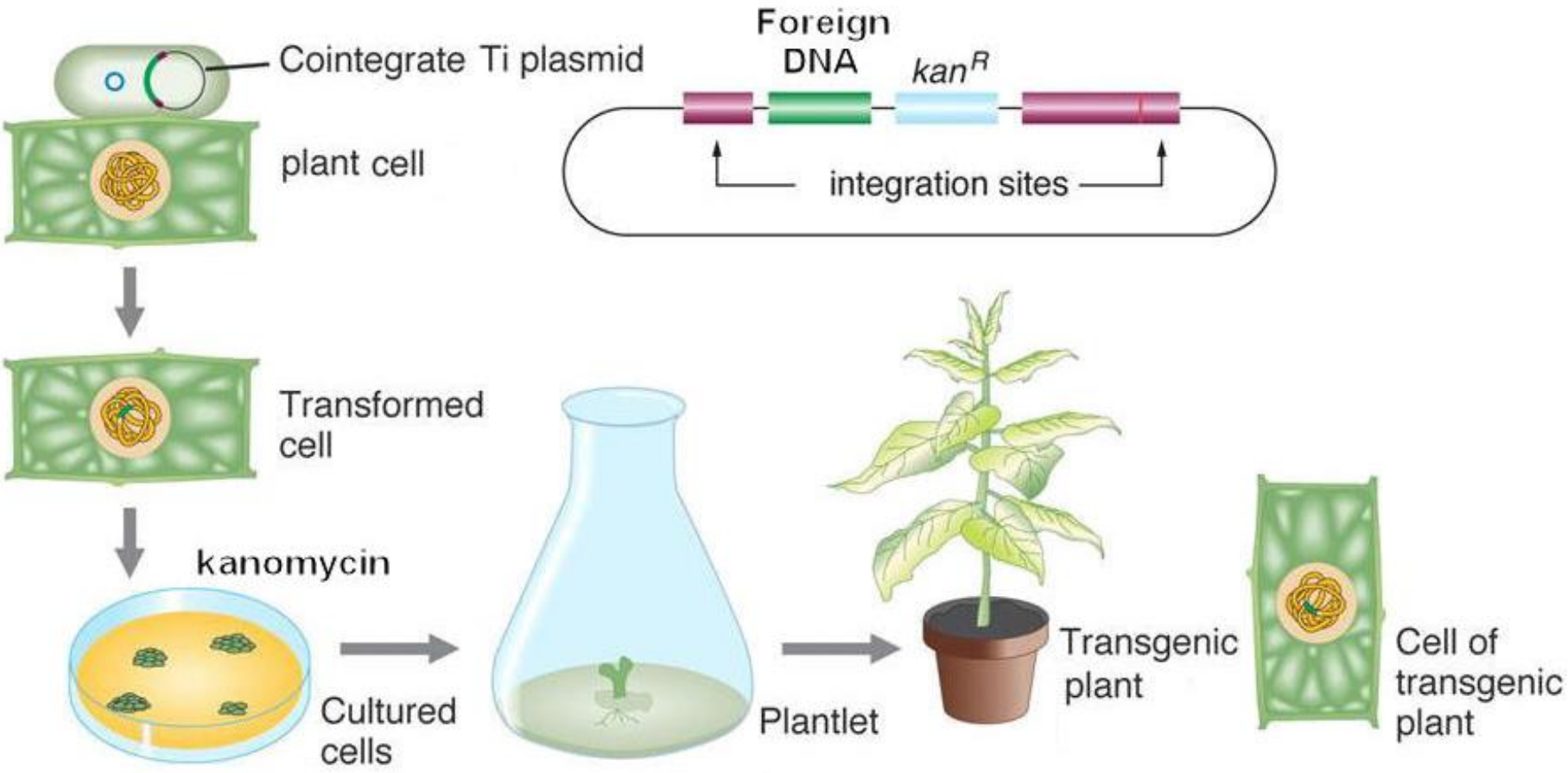
7.3 Genetically Modified Plant

- ***Agrobacterium tumefaciens***



7.3 Genetically Modified Plant

- ***Agrobacterium tumefaciens***



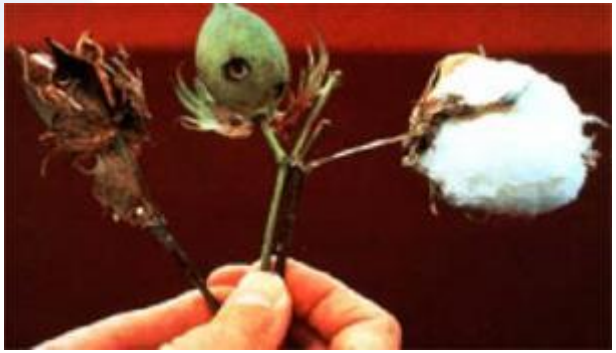
7.3 Genetically Modified Plant

- **Gene gun/Biolistic bombardment system**
  - **Used to blast tiny metal beads coated with DNA into an embryonic plant cell**
  - **Aimed at the nucleus or the chloroplast**
  - **Use marker genes (antibiotic resistance) to distinguish genetically transformed cells**
  - **useful in plants that are resistant to *Agrobacterium***

http://www.instruction.greenriver.edu/mcvay/es204/es%20docs/animations/transgenic_plants.swf

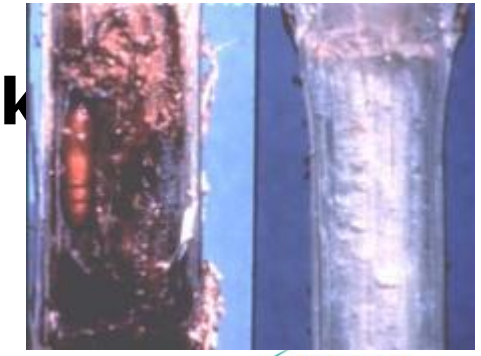
7.3 Genetically Modified Plant

- **Examples of GM crops**



Insect resistant cotton – Bt toxin kills the cotton boll worm

Insect resistant corn – Bt toxin k
European corn borer



7.3 Genetically Modified Plant

- **Examples of GM crops**

Herbicide resistant crops
- soybean, corn, canola

Virus resistance - papaya resistant to papaya ringspot virus

7.3 Genetically Modified Plant

- **Gene gun/Biolistic bombardment system**

Golden Rice – increased Vitamin A content

Discussion

- What is the advantages of GM plant/crops?

Discussion

Describe the process of making fish tomato.

Antifreeze gene from winter flounder

Tomato

GM Tomato


Monsanto,
I presume.
www.JoeMonr.com


STOP!!
IS THAT
GM BREAD??
YEAH!
HOW'D YOU
KNOW?
Chatfield
WWW.JASONCHATFIELD.COM

7.4 Animal cloning

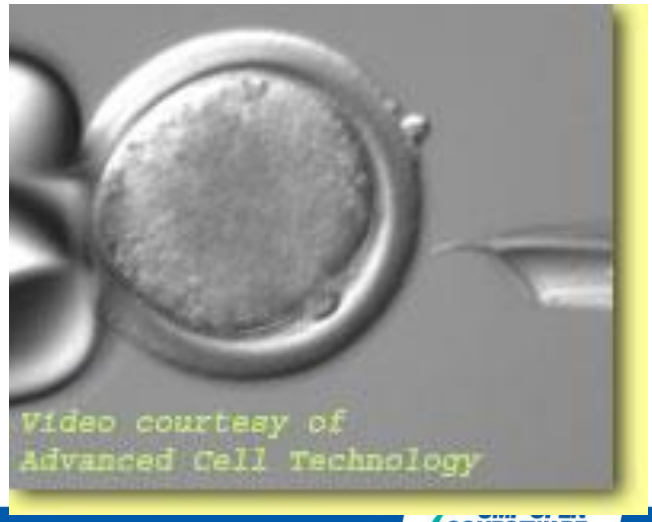
- Cloning - the creation of an organism that is an exact genetic copy of another
- Clones are not exactly identical
  - Shaped by experiences and environments
- Clones may be old before their time
  - Shortened telomeres
- Example: Dolly the ship

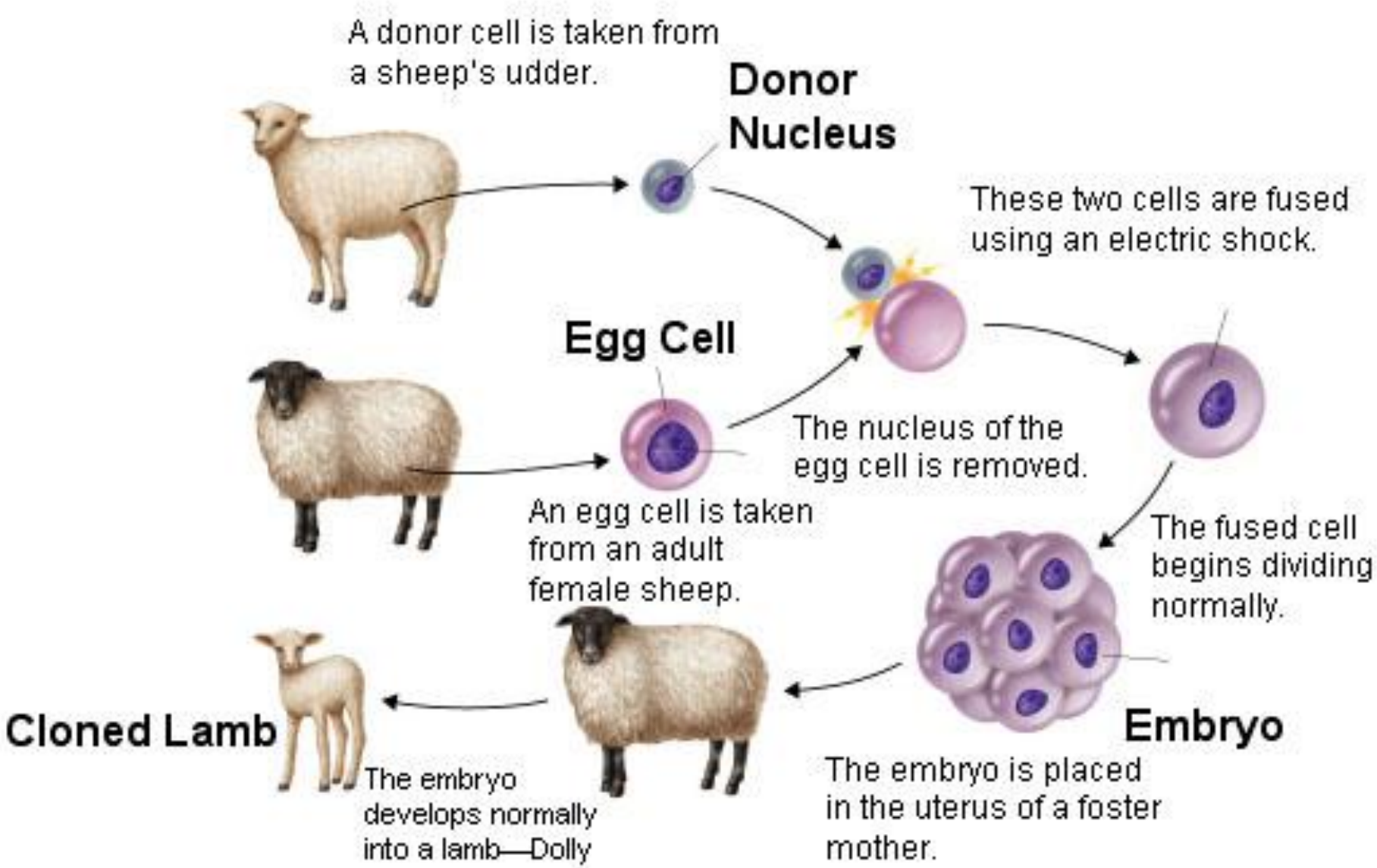

OK, CLONE! HERE'S ALL MY HOMEWORK!
NO WAY, MAN!
Genetics
Math
English
CLONE-SELF
INSTANT!
Somatic Cell Nuclear Transfer KIT

7.4 Animal cloning

- DNA from donor cell must be inserted into an egg
- Egg is prepared by enucleation
  - Pipette suctions out the nucleus
- DNA from donor cell put into egg cell
- Embryo is transferred to a surrogate mother for gestation

http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/





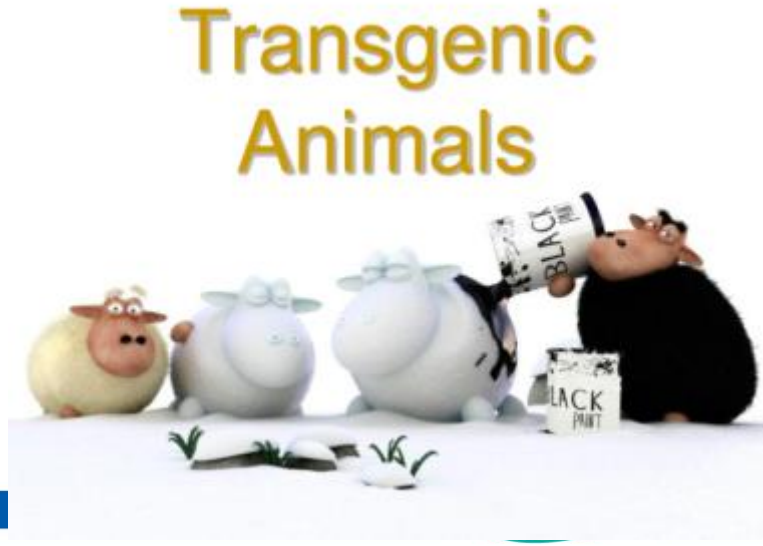
http://learn.genetics.utah.edu/content/tech/cloning/whatiscloning/scnt.html

Discussion

- Is it possible to clone a dinosaur?

7.5 Genetically modified animal

- Genetically modified animal / transgenic animal:
  - **Animals which have been genetically engineered to contain one or more genes from an exogenous source.**
- Improve genetic Features of domesticated Animals

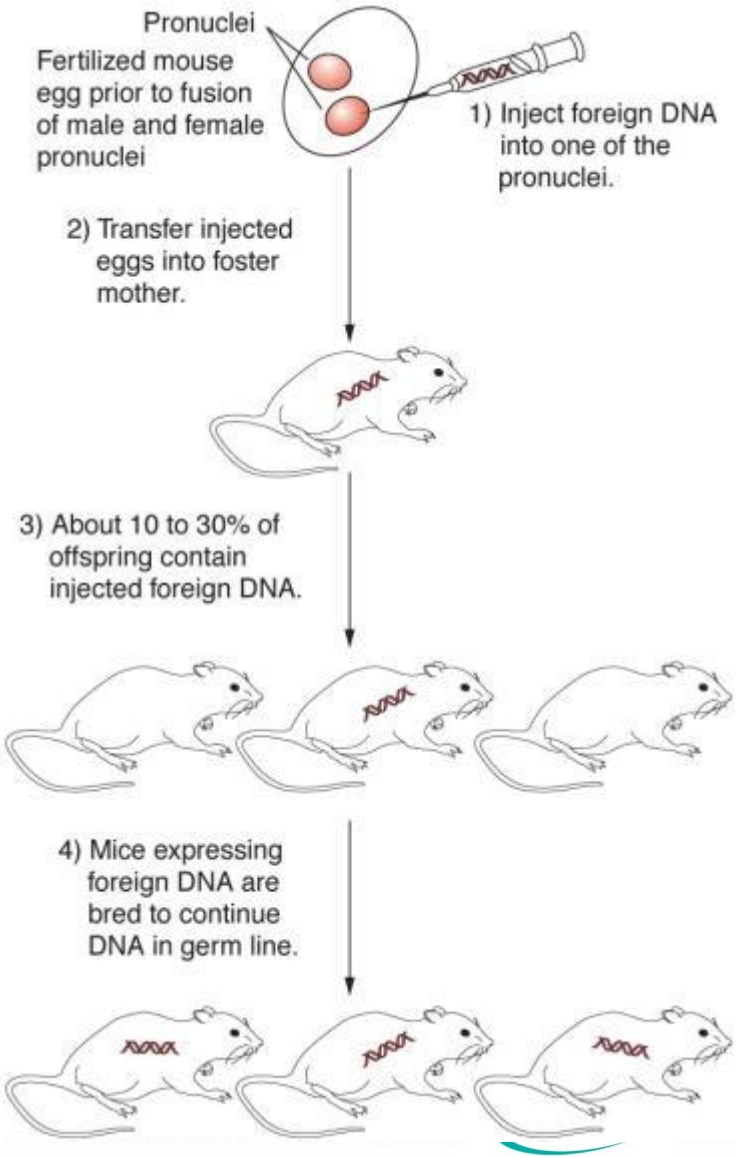


7.5 Genetically modified animal

- Three major method for the creation of a transgenic animal:
  - Nuclear microinjection
  - Retrovirus-mediated gene transfer
  - Embryonic stem cell-mediated gene transfer

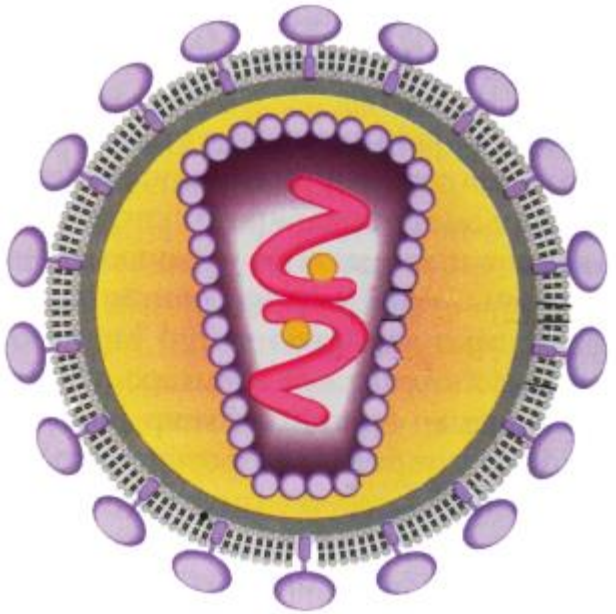
7.5 Genetically modified animal

- Nuclear microinjection
  - **Introduces the transgene DNA at the earliest possible stage of development of the zygote**
  - **DNA is injected directly into nucleus of egg or sperm**



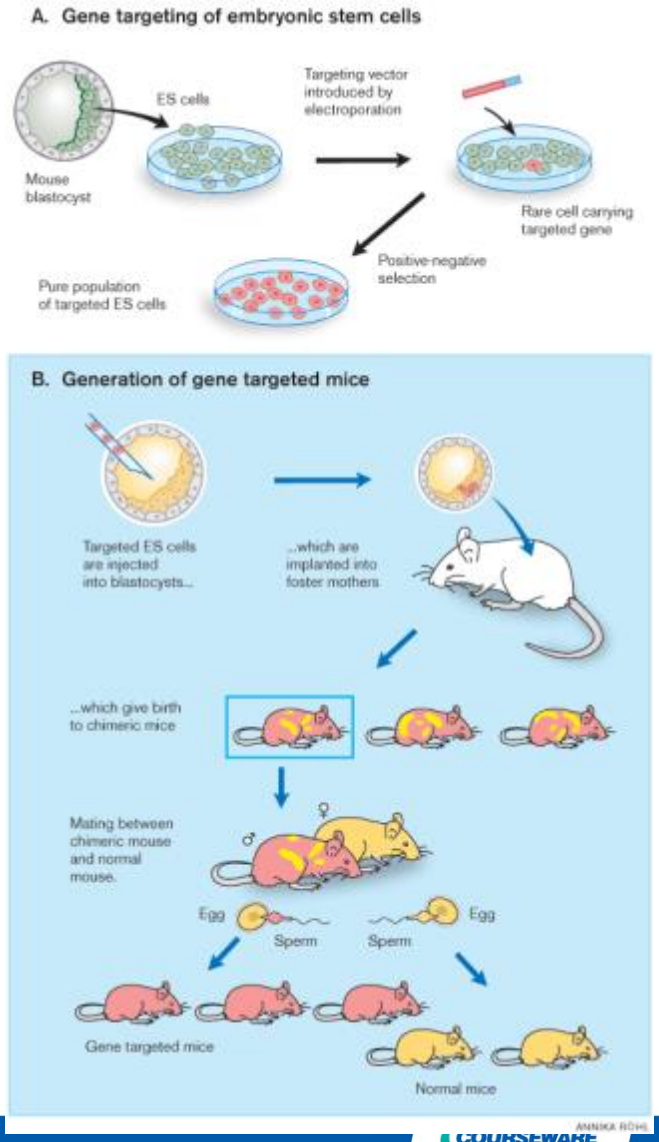
7.5 Genetically modified animal

- Retrovirus-mediated gene transfer
  - **Infecting mouse embryos with retroviruses before the embryos are implanted**



7.5 Genetically modified animal

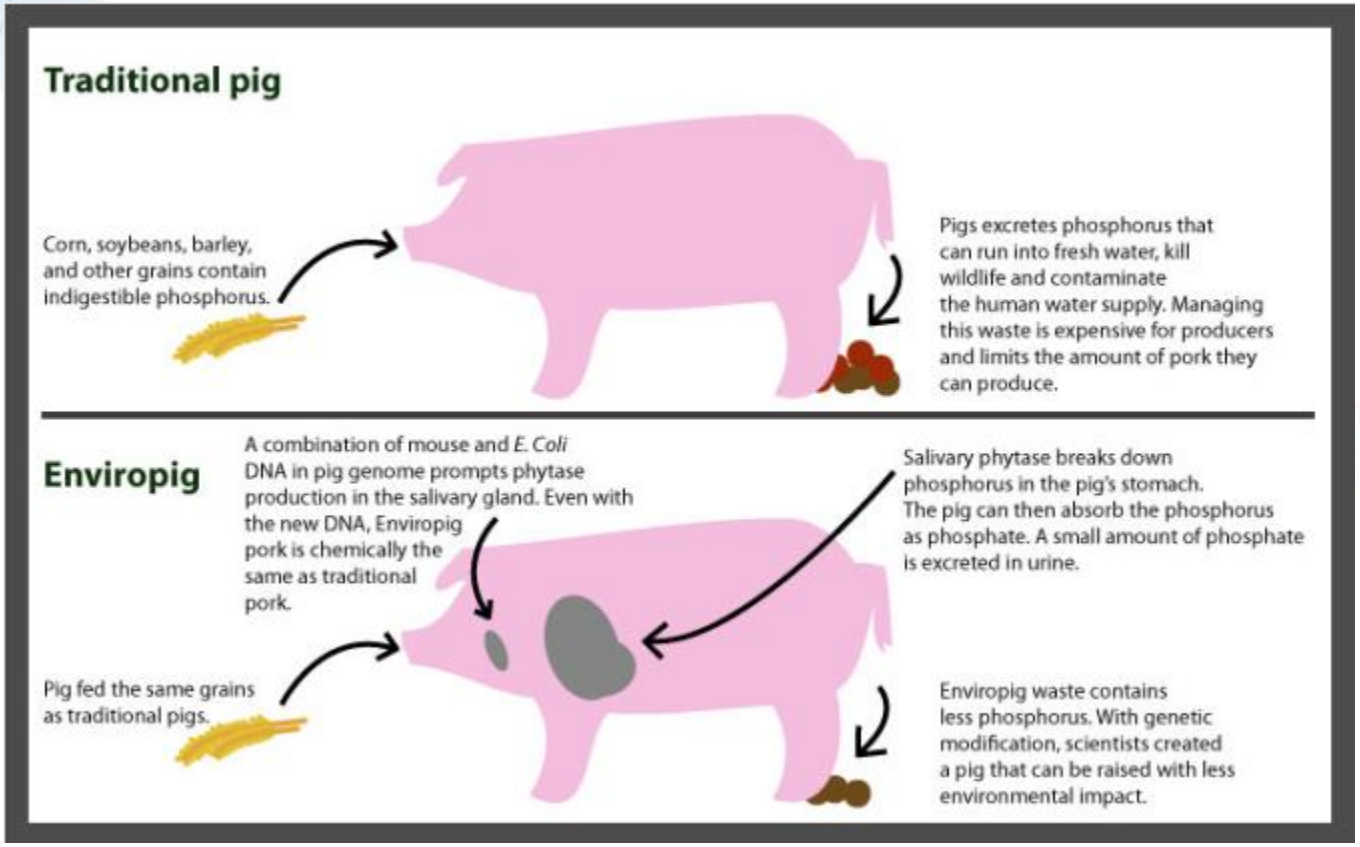
- Embryonic stem cell-mediated gene transfer
  - **Embryonic stem cells are mixed with DNA and will absorb the DNA**



http://www.nobelprize.org/nobel_prizes/medicine/laureates/2007/advanced.html

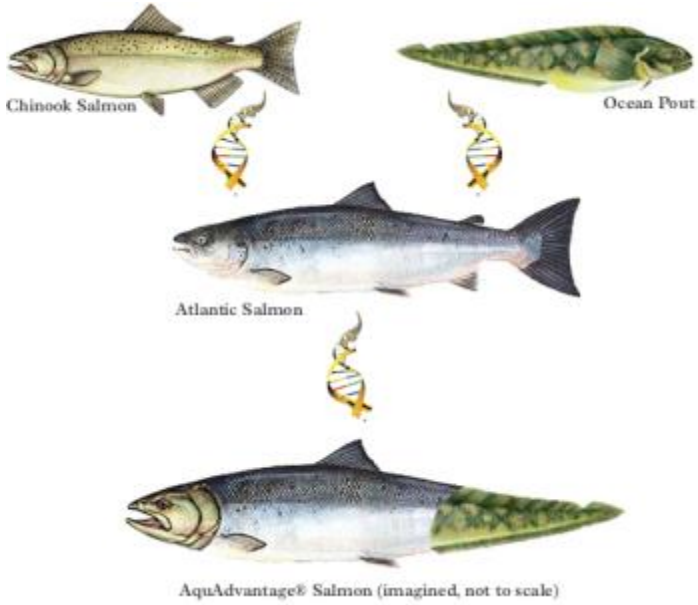
7.5 Genetically modified animal

- Example of GM animals



7.5 Genetically modified animal

- Example of GM animals
- GM salmon
- AquAdvantage salmon



AquAdvantage® Salmon (imagined, not to scale)

Extra reading

- http://www.scq.ubc.ca/your-guide-to-plant-cell-culture/
- http://www.dnatube.com/video/5576/FlavrSavr-TomatoFirst-Transgenic-Crop
- http://www.monsanto.com/Pages/default.aspx
- http://palmer-dna-tech-project-2012.wikispaces.com/Rachel+Laufmann
- http://learn.genetics.utah.edu/content/tech/cloning/
- http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/

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