

## Genetics

### 3.5- Genetic Modification and Biotechnology

The image shows a collage related to genetics. On the left, a gel electrophoresis image displays several DNA bands. In the center, a sheep is shown. On the right, two cats are shown, one glowing orange and the other glowing green. Below these images is a diagram of a pGLO plasmid, a circular DNA molecule with various components labeled: Amp<sup>r</sup> (Ampicillin resistance gene), pGLO (LacZ gene), and an origin of replication. The diagram also shows the plasmid being inserted into a cell.

### Essential idea:

- Biologists have developed techniques for artificial manipulation of DNA, cells and organisms.

The image illustrates the essential idea with a person holding a DNA model and a glowing cat. The glowing cat is shown in two different colors, orange and green, representing genetic modification.

### Nature of Science:

- Assessing risks associated with scientific research
  - scientists attempt to assess the risks associated with genetically modified crops or livestock. (4.8)

**Pros:**

Increased pest- and disease-resistant crops

**Cons:**

Development of antibiotic resistance in humans

Inadvertent creation and introduction of new allergens in crops

**Pros:**

Drought- and self-tolerant crops

### Nature of Science:

- Japan: "Popeye Pigs"
  - Inserted with a spinach gene that converts saturated fat into unsaturated fat (linoleic acid).

### Applications and Skills

- Application: Assessment of the potential risks and benefits associated with genetic modification of crops.

Trait	Advantage	Sample Product
Pest-Resistance	Less damage by insect, virus, bacteria, etc.	Corn
Herbicide-Resistance	Herbicides will kill only weeds, not crops	Cotton
Delayed Ripening	Can be shipped with less damage	Tomato
Miniature Size	Improved eating quality	Watermelon
Improved Sweetness	Better tasting	Sweet peas
Cold-Resistance	Withstands freezing and thawing	Strawberries
High Starch	Absorbs less oil when fried	Potato
Polyester Gene Added	Better fiber properties	Cotton
Growth Hormone Added	Faster growth	Salmon
Hepatitis B Virus Protein Added	May provide immunity to Hepatitis	Banana

### Applications and Skills

- Skill: Analysis of data on risks to monarch butterflies from Bt crops.
  - Bacillus thuringiensis* (Bt) is a soil bacterium that produces insecticidal toxins.
  - Genes from Bt have been inserted into maize so GM plants can produce an insecticidal toxin and therefore be resistant to pests, e.g. European Corn Borer

The diagram illustrates the mechanism of Bt toxin action. It shows a monarch butterfly larva ingesting Bt spores. The spores germinate and release toxins. These toxins are activated to active toxins by gut enzymes. The active toxins bind to receptors on the midgut membrane, causing it to perforate and leading to starvation or septicaemia. Activated toxins bind to the receptors, subsequently inserting into the membrane and causing leakage of ions and small molecules.

## Applications and Skills

- Skill: Analysis of data on risks to monarch butterflies from Bt crops.

- Homework
- Go to

- <https://www.ars.usda.gov/oc/br/btcorn/index/>
- <http://do.ces.cornell.edu/13/genetics/wormcontrol.html>
- <http://www.epa.gov/pesticides/ohp/pesticides-general-public/monarch-butterflies/eng/13381417/133814022493>

Follow [Evaluation of Evidence and Methods for Scientific Claims Handout](#) and write an opinion of the risk to monarch butterflies.



## Theory of knowledge

- The use of DNA for securing convictions in legal cases is well established, yet even universally accepted theories are overturned in the light of new evidence in science.
  - What criteria are necessary for assessing the reliability of evidence?
  - How do you make your choices?

### HOW THEY COMPARE

**GM salmon**  
Length: 24lbs  
Weight: 6.6lb

**Farm salmon**  
Length: 13lbs  
Weight: 2.8lb

\*Both fish are 18 months

### LEARN YOUR LABELS

**SHAVED WITH PESTICIDES** (4189)

**100% ORGANIC & FREE OF PESTICIDES** (1476)

**GENETICALLY MODIFIED** (1476)

## Understandings

- Gel electrophoresis is used to separate proteins or fragments of DNA according to size.

Figure S-2: Gel Electrophoresis

- Restriction enzymes cleave DNA into smaller segments of various sizes.
- DNA segments are loaded into wells in a porous gel. The gel floats in a buffer solution within a chamber between two electrodes.
- When an electric current is passed through the chamber, DNA fragments move toward the positively-charged cathode.
- Smaller DNA segments move faster and farther than larger DNA segments.

## Understandings

- PCR can be used to amplify small amounts of DNA.

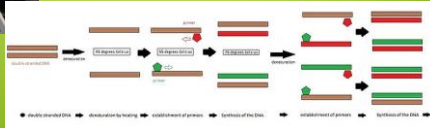
- Denaturing:** Heat to 95°C. DNA strands will separate.
- Annealing:** 55°C. Primers bind to template DNA strands.
- Extension:** 72°C. Taq polymerase synthesizes new DNA strands.

Two new DNA molecules

### Remember 2.7 Notes

## Polymerase Chain Reaction (PCR)

- Occurs in a thermal cycler and involves a repeat procedure of 3 steps:
  - Denaturation: DNA sample is heated to separate it into two strands
  - Annealing: DNA primers attach to opposite ends of the target sequence
  - Elongation: A heat-tolerant DNA polymerase (Taq) copies the strands



## Understandings

- DNA profiling involves comparison of DNA.

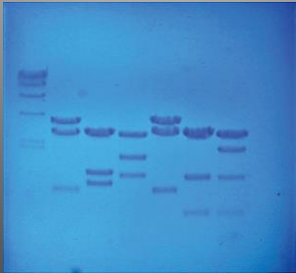
**Suspects** (lanes 1-7)

**Bloodstain** (lanes 4-7)

**Mother, Child, Alleged Father** (lanes M, C, F1, F2)

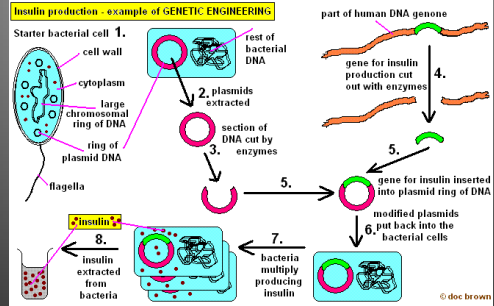
## Applications and Skills

- Application: Use of DNA profiling in paternity and forensic investigations.
  - Ex: DNA Fingerprinting Lab



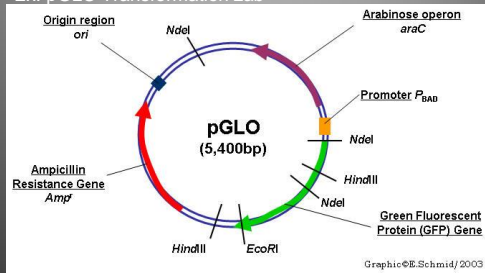
## Understandings

- Genetic modification is carried out by gene transfer between species.



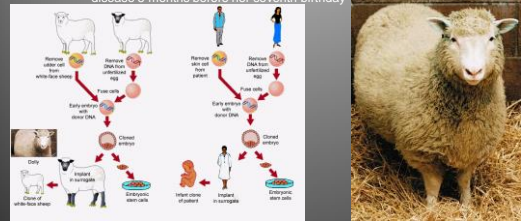
## Applications and Skills

- Application: Gene transfer to bacteria using plasmids makes use of restriction endonucleases and DNA ligase.
- Ex: pGLO Transformation Lab



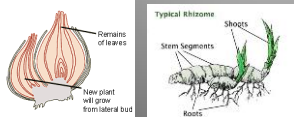
## Understandings

- Clones are groups of genetically identical organisms, derived from a single original parent cell.
  - Dolly
    - Cloned by Ian Wilmut, Keith Campbell and colleagues at the Roslin Institute, Scotland.
    - She was born on 5 July 1996 and put down due to a progressive lung disease 5 months before her seventh birthday.



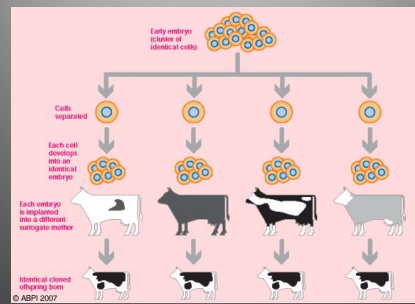
## Understandings

- Many plant species and some animal species have natural methods of cloning.
  - Plants: Bulbs, Runners, Rhizomes
  - Animals: Parthenogenesis



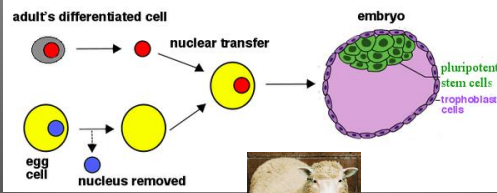
## Understandings

- Animals can be cloned at the embryo stage by breaking up the embryo into more than one group of cells.



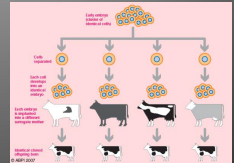
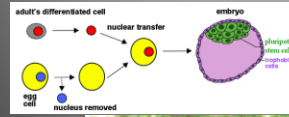
## Understandings

- Methods have been developed for cloning adult animals using differentiated cells.



## Applications and Skills

- Application: Production of cloned embryos produced by somatic-cell nuclear transfer.
  - Mass production of one organism.
  - Good/Bad?



## Applications and Skills

- Skill: Design of an experiment to assess one factor affecting the rooting of stem-cuttings.

- African violets
- Geranium
- Mock Orange
- Plum
- Rose
- Boxwood
- Citrus
- Euonymus
- Holly
- Olive

