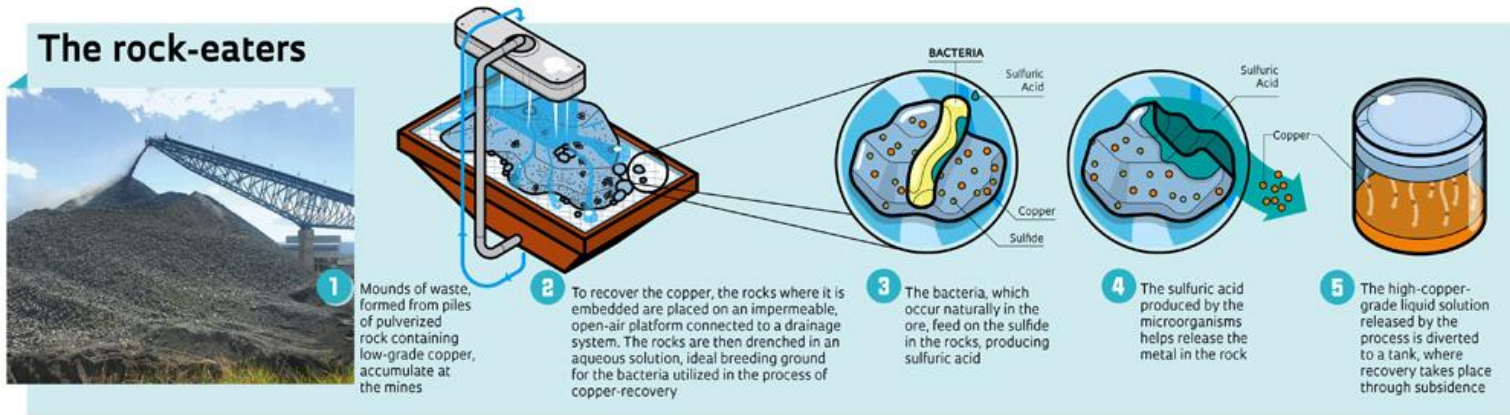


## Biomining: How is biotechnology used to mine copper?



**Biomining** is a process in which microbes such as bacteria, are used to speed up bioleaching, the process of breaking down the minerals surrounding metal ore. Currently, the biomining process has improved the recovery of the world's gold by 5% and copper by 10-15%. Using microbes to recover metals like copper can improve the recovery rates mined from a site by 60% to 90%. The image to the right shows a lab technician monitoring columns containing rock, acid solution, and bacteria.



<http://www.bbc.com/news/technology-17406375>

“All the flasks, tubes, containers and huge tanks are full of microbes: *Acidithiobacillus ferrooxidans* and *Thiobacillus ferrooxidans* bacteria, harnessed by the firm to break down minerals.”

### How does biomining compare to more conventional mining methods?

- Biomining techniques can recover a greater percentage of the ore at each site.
- Less energy is required for biomining than conventional methods.
- The biomining process reduces the environmental impact on soil and water compared to conventional mining techniques.
- Some of the bacteria used in the biomining process can reduce the amount of heavy metals formed during the conventional mining process.

### **What are the future hopes for biomining?**

Scientists hope to continue their research on extremophile bacteria (bacteria that live in extreme environments) in order to recover more metals from abandoned mines while improving the environmental conditions of the sites. Scientists continue their search for new microbes that can accomplish this type of work.

### **Video Clip from the BBC giving an overview of biomining.**

Bioming: How microbes help mine copper?

By Katia Moskvitch, 20 March 2012, BBC Technology News

<http://www.bbc.com/news/technology-17406375>



*A. cylindrical is a bacteria are extremophiles and can breakdown minerals that are bound to the metal*

### References:

Bioming: How microbes help mine copper?

By Katia Moskvitch, 20 March 2012, BBC Technology News

<http://www.bbc.com/news/technology-17406375>

Microbes 'to tackle mine waste', Wednesday, 6 April, 2005, BBC News

[http://news.bbc.co.uk/2/hi/uk\\_news/wales/4417051.stm](http://news.bbc.co.uk/2/hi/uk_news/wales/4417051.stm)

Space Colonists Could Use Bacteria to Mine Minerals on Mars and the Moon

By Charles Choi, Sept 10, 2010, Scientific American

<http://www.scientificamerican.com/article/space-colonists-could-use-bacteria/>

Bioleaching:

<http://www.biosigma.cl/en/productos-y-servicios/tecnologias-de-biolixiviacion/>

Infographic on biomining

<http://revistapesquisa.fapesp.br/en/2012/10/20/microbes-that-mine/>

Microbes that Mine, by YURI VASCONCELOS | Edition 200 - October 2012

<http://revistapesquisa.fapesp.br/en/2012/10/20/microbes-that-mine/>

Mining with Microbes, by Sarah Everts, Volume 90 Issue 42 | pp. 34-35

Issue Date: October 15, 2012, Chemical and Engineering News

<http://cen.acs.org/articles/90/i42/Mining-Microbes.html?h=1836741176>

## Glofish, the Genetically Modified Pet

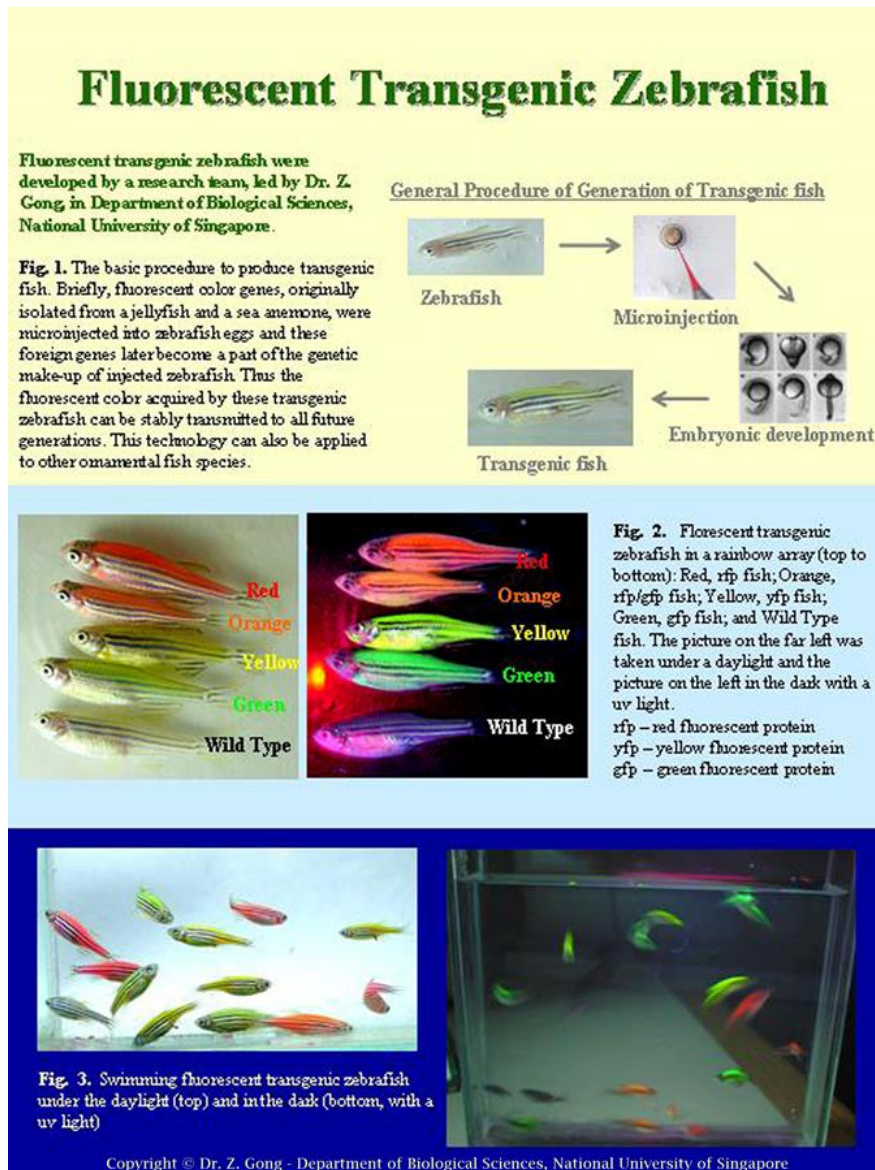
Glofish have been in our pet stores and homes for more than ten years. These fluorescent fish are a trademarked organism that has been genetically modified by introducing glowing genes from coral into a zebrafish. This is the first genetically modified organism sold as a pet in United States.

The actual development of this glowing zebrafish occurred as part of a much larger research project. In 1999, Dr. Zhiyuan Gong and his colleagues, at the National University of Singapore, took a gene that produces the green fluorescent protein (the gene responsible for making jellyfish fluoresce) and placed it in a zebrafish embryo. The genetically modified zebrafish glowed green and was able to pass the glowing gene to its young. The culminating goal of Dr. Zhiyuan's research project is to develop a fish that will fluoresce only when it is in the presences of pollutants.



Image: <http://www.glofish.com/meet-glofish/glofish-gallery/>

### How is a Glofish made?



## How did Yorktown Technologies get the Glofish approved?

The approval of the Glofish by the FDA on December 9, 2003 was due to Yorktown Technologies' careful work and research to address possible concerns about their product. It had to provide documentation to the FDA to show that the genetically modified Glofish would not have a negative impact on the environment or on public health. Yorktown Technologies conducted risk analysis and safety assessment of fluorescent protein to verify that they would be safe. These assessments were conducted by several scientists and each document is posted on their website (<http://www.glofish.com/about/glofish-science/#fishdata>). However, approval in California is pending a formal review of the Glofish's impact on the environment. The CEO of Yorktown Technologies, Alan Blake, asserts that the cost of this formal review would not be feasible and suggests that residents of California should talk to their state representatives if they want Glofish available in their state. Listen to the Pet Life Radio podcast interview of Alan Blake in 2009.

[http://www.petliferadio.com/alan\\_blake.html](http://www.petliferadio.com/alan_blake.html)

## What are some other applications for glowing zebrafish?

The video "Fishing for Answers" highlights the work of Dr. Len Zon, a researcher at Harvard Medical School and practicing oncologist at the Children's Hospital in Boston.

<http://www.pbs.org/wgbh/nova/blogs/secretlife/health-science/len-zon/>

## References:

The Science of Glofish: (from the company's webpage)

<http://www.glofish.com/about/faq/#science>

Glofish and the Environment: (from the company's webpage)

<http://www.glofish.com/about/faq/#environment>

FDA Statement Regarding Glofish

<http://www.fda.gov/AnimalVeterinary/NewsEvents/FDAVeterinarianNewsletter/ucm106233.htm>

California Band on Glofish: (from the company's webpage)

<http://www.glofish.com/about/faq/#california>

## Recombinant DNA Technology and Transgenic Animals

By: Leslie Pray, Ph.D. © 2008 Nature Education

Citation: Pray, L. (2008) Recombinant DNA technology and transgenic animals. Nature Education 1(1):51

<http://www.nature.com/scitable/topicpage/recombinant-dna-technology-and-transgenic-animals-34513>



## De-Extinction:

Is the process of inserting DNA of extinct organisms into a host egg in order to recreate the extinct species. This cloning process is called somatic cell nuclear transplantation and requires well preserved DNA. In fact, that is why the mammoth and the passenger pigeon were chosen to be recreated because both have well preserved DNA and their genome can be reconstructed from the well preserved remains. De-extinction would not be possible using ancient DNA. Therefore, the fictional story Jurassic Park would not be possible due to the quality of the remnant tissues and the lack of DNA present in the fossilized remains.

### THE NUCLEAR TRANSFER (CLONING) PROCESS

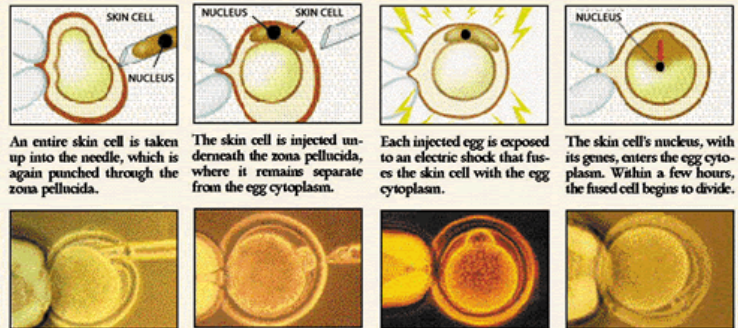
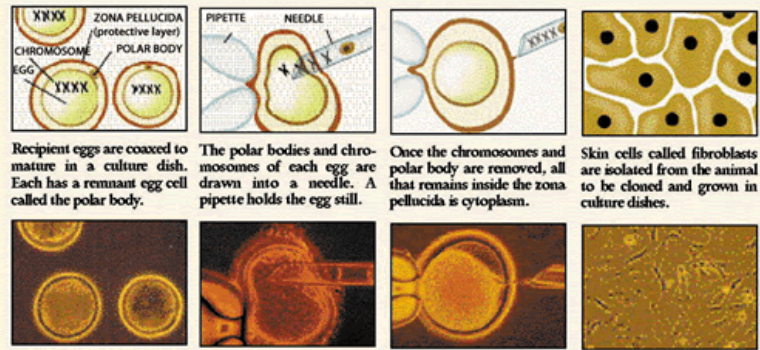


Image: <http://www.biology.iupui.edu/biocourses/Biol540/12cloningfullCSS.html>

### Reborn from the Museum

How scientists hope to bring back the extinct passenger pigeon

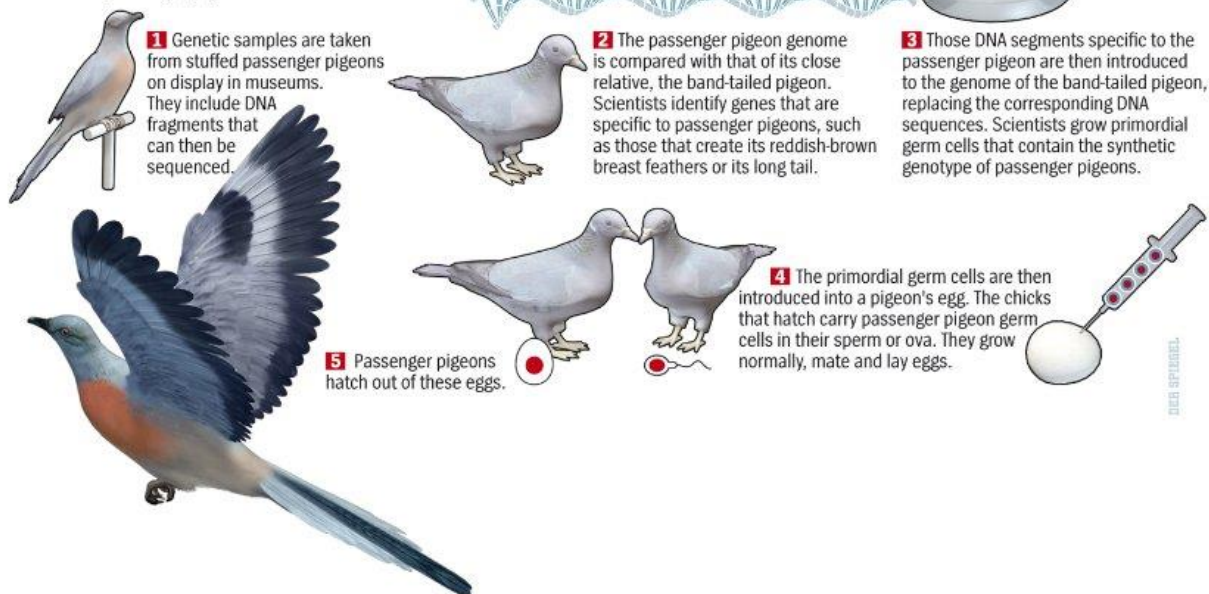


Image: <http://www.spiegel.de/international/zeitgeist/bild-893744-483223.html>

The video linked below reviews the Passenger Pigeon Project and the process used in this de-extinction project.

“Recipe for Resurrection”: <http://www.nationalgeographic.com/deextinction/>

## What are the issues surrounding the de-extinction projects?

Here are some of ideas that have been presented for and against the de-extinction project.

Concerns Associated with De-Extinction Projects	Benefits Associated with De-Extinction Projects
<ul style="list-style-type: none"><li>• Reviving extinct organisms can have a destabilizing effect on the environment.</li><li>• Unintended consequences such as disease may result.</li><li>• Distractions may stop funds from going towards current conservation projects.</li><li>• Conservation dependency of de-extinct species may be high; reintroduced organisms will require ongoing support to maintain the new population.</li><li>• Reintroduced organisms may not have the environmental mechanisms to adapt to change.</li></ul>	<ul style="list-style-type: none"><li>• De-extinct species may provide ecological partners like pollinators or seed dispersers to maintain current diversity.</li><li>• Species that have been reinstated will be flagship species that inspire habitat protection and benefit other species.</li><li>• Research on de-extinction can also be used to maintain organisms that are endangered or threatened.</li><li>• Research will benefit other science fields including agricultural and medical sectors.</li><li>• People have been the cause of many extinctions and are also responsible for reviving extinct organisms.</li></ul>

Watch the ted talks to gain a better understanding of issues surrounding de-extinction.

**TedxDeExtinction Videos – Cover the controversy surrounding de-extinction projects**

<http://tedxdeextinction.org/>

### References:

Ted x DeExtinction Videos

<http://tedxdeextinction.org/>

Recipe for Resurrection:

<http://www.nationalgeographic.com/deextinction/>

**Successful de-extinction project:**

Extinct frog resurrected with ‘de-extinction’ technology

The Hopes Australian Lazarus Project provides stepping stone for other extinct species such as the Tasmanian tiger, Australian Associated Press, theguardian.com, Thursday 21 November 2013 21.11 EST

<http://www.theguardian.com/environment/2013/nov/22/extinct-frog-resurrected-with-de-extinction-technology>

**Video of Frog Giving Birth: YouTube video with a young and hyperactive presenter**

<https://www.youtube.com/watch?v=mA9yJkK7xXk>

**National Geographic Video of a male frog giving birth: Less dramatic**

[http://video.nationalgeographic.com/video/frog\\_strawberrypoison.dart\\_tadpole?source=relatedvideo](http://video.nationalgeographic.com/video/frog_strawberrypoison.dart_tadpole?source=relatedvideo)

## The Mammoth Cometh

Bringing extinct animals back to life is really happening — and it's going to be very, very cool. Unless it ends up being very, very bad.

By NATHANIEL RICH FEB. 27, 2014

[http://www.nytimes.com/2014/03/02/magazine/the-mammoth-cometh.html?\\_r=0](http://www.nytimes.com/2014/03/02/magazine/the-mammoth-cometh.html?_r=0)

## Back From the Dead: Why De-Extinction May Save Humanity

By John Roach, July 24, 2014

<http://www.nbcnews.com/science/environment/back-dead-why-de-extinction-may-save-humanity-n164226>

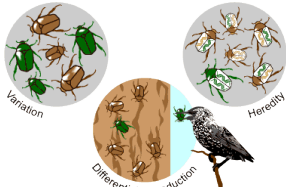
Trends in Ecology & Evolution, Volume 29, Issue 3, March 2014, Pages 140–147

Reintroducing resurrected species: selecting DeExtinction candidates

Philip J. Seddon<sup>1</sup>, Axel Moehrenschrager<sup>2</sup>, John Ewen<sup>3</sup>

<http://www.sciencedirect.com/science/article/pii/S0169534714000214>

**What are the mechanisms for evolutionary change?**



<http://evolution.berkeley.edu/evolibrary/images/interviews/naturalselection1.gif>

- 1.
- 2.
- 3.
- 4.
- 5.

**Stop and Jot**  
Share your answer with your teacher ; )

What is an example of evolutionary change from the video and the name of the mechanism that caused it?

**Artificial Selection**



A Punnett square can be used to predict the outcome of certain crosses. For \_\_\_\_\_ breeding Punnett squares can be used to predict the characteristics of the offspring.

1. What does recessive and dominant mean?
2. What is a genotype?
3. What does it mean to be homozygous and heterozygous for a particular trait?

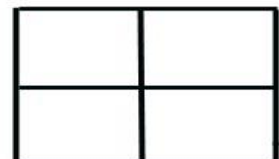
**STOP and JOT**

During our lab set up today, you set up a cross between a P<sub>1</sub> seedling with a Non-purple recessive allele, which we will represent with a "p" and a P<sub>2</sub> a purple dominate allele, which we will represent with a "P". Both of the parents are homozygous for their traits. What will be the first generation (F<sub>1</sub>) look like? What would the second generation look like?

**Parental cross to produce F<sub>1</sub>**



**Second Generation F<sub>1</sub> x F<sub>1</sub>**





**Artificial Selection:**

**What is selective breeding?**

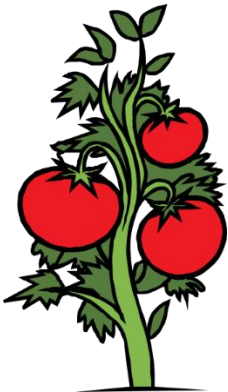


What is selective breeding?

Fill in the Punnett square representing one of your crosses:  
Label the parents traits and the traits of the offspring.


**Artificial Selection:**

How do you create a genetically modified, GM crop/transgenic manipulation crop?



<http://www.clipartbest.com/clipart-LcKaq8pca>

1.

2.

3.

4.

5.

6.

7.

8.

**STOP and JOT**

Write a M.E.A.L. to answer one of the following questions:

What causes organisms to change over time  
(mechanisms of evolution)?

How are biotechnology and selective breeding used to change plants and animals over time?

Why do we use Punnett squares?

How has artificial selection impacted the way our Earth looks today?

Share your answer with your teacher ; )

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De-Extinction:

How is an animal brought back from extinction?

What animal would you like to see brought back from extinction?

UP Side:

Down Side:

How could this impact other living things?

Glowfish (Genetically Modified Pets):

How is a genetically modified organism made?

What would be your dream GM pet?

UP Side:

Down Side:

Could genetically modified pets impact other living things?

## Graphic Organizer for New Biotechnologies

Name: \_\_\_\_\_

Genetically Modified Crops:

How is a GM crop made?

There are now grapes that taste like cotton candy. If you could, what flavor would you choose a fruit to be?

UP Side:

Down Side:

Will GM crops impact other living things?

Biomining:

What is needed for biomining?

What jobs would you like bacteria to do for you?

UP Side:

Down Side:

Could bioming impact other living things?

**Group Graphic to Analyze the Ethical Use of New Biotechnology.**

**How can biotechnology impact our society and environment? What are some possible ways that we should regulate/control this new technology?**

