

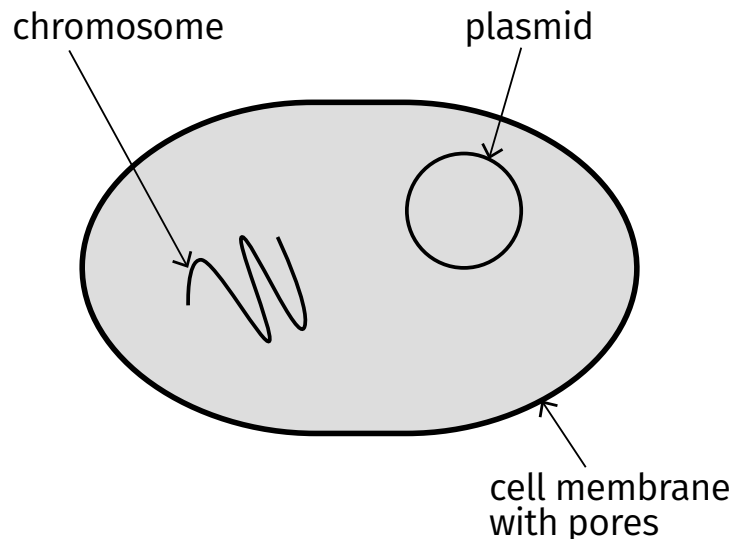
Plasmid modeling

How does genetic modification work?

Genetic modification is different than crossing different varieties of the same plant species. It is taking a gene from one species and inserting it into the genetic material of another, different species. This is what makes it so specific. We have been able to modify bacteria to produce insulin for humans that is genetically identical to the insulin produced in a human pancreas. How is this possible?

Scientists have been able to isolate genes that code for specific traits through **genome** studies (discovering the DNA of an entire organism). Proteins, called **restriction enzymes**, have been discovered and used to cut out the desired gene from the strand of DNA. Scientists have also used various bacteria to act as vectors that can carry genetic material. A process called **PCR** (polymerase chain reaction) makes hundreds of thousands of copies of the desired gene then creates enough copies to be inserted into bacteria or another vector.

The transformed cells can be selected for replication (for example, another gene for antibiotic resistance is added to the plasmid along with the gene of interest; when the cells grow on a plate that has the antibiotic, the transformed cells are the only ones that grow.) These transformed vectors are used to transfer the gene to the desired species.



Materials

- Plastic bottle or balloon
- Pop beads of three different colors in bunches of 10–15 each

Instructions

This activity will model the steps of gene isolation, the use of restriction enzymes to remove the gene from a species that has it as part of its DNA, then add it to a plasmid that can be replicated, then inserted into a bacteria/vector to be transferred to another species.

1. *Model the genes of interest:* Using 8–10 beads of one color, create a strand of beads to represent the gene (Green Fluorescent Protein-GFP) you want to use to genetically modify another species through gene insertion (i.e. into a bacteria/vector)
2. *Create a strand of DNA in a jellyfish:* Include beads of the other two colors both above and below the beads from #1, to represent the strand of DNA that this gene is found within.
3. *Create a “gene” for antibiotic resistance:* Using 8–10 beads of a different color. Set this aside for now.
4. *Model the restriction enzyme action:* Remove the “gene” for GFP from the strand of DNA created in #2.
5. (Many copies of this gene will be made through PCR, however, we do not need to model this step.)
6. Add the gene for GFP to the gene for antibiotic resistance made in #3.
7. Attach the beads at each end to make a circular piece of DNA (plasmid).

Extension

Watch “Restriction Enzymes” at [youtube.com/watch?v=U2cKywEn6KY](https://www.youtube.com/watch?v=U2cKywEn6KY)

1. Which steps above are using restriction enzymes?
2. Modify the instructions above to include the letters of nitrogen bases that may be “cut” if using EcoRI as the restriction enzyme.

Next steps

1. The plastic bottle or balloon is the bacteria model. How might we get the genes inside the bottle?
2. What will happen to the cell membrane if we heat the bacteria a bit? (Think of yourself in a hot tub or sauna.) What will happen to the cell membrane if we put it in ice water? (Think of yourself on a chilly day without a coat on.)
3. How could the conditions in #2 help us get the plasmid in the bottle or balloon?