# Journey to Diptera Island

This curriculum unit is designed to be used in conjunction with the PDA participatory simulation, Live Long and Prosper, created by the Teacher Education Department at MIT. For more information about participatory simulations please visit http://education.mit.edu/pda/index.htm.

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# Journey to Diptera Island

## Curriculum/Learning Objectives

***Upon completion of the unit students will be able to:***
**Differentiate** between genotype and phenotype.
**Apply** the terms genotype and phenotype appropriately.
**Utilize** data to support predictions for determining phenotype and genotype.
**Explain** the terms homozygous dominant, homozygous recessive and heterozygous.
**Utilize** data to determine traits that are associated with homozygous dominant, homozygous recessive and heterozygous conditions.
**Differentiate** between "commonality" of traits and "dominance" of genes.
**Construct** and use Punnett Squares to explain how a single genetic traits are combined and passed to offspring.
**Calculate** the probability of simple phenotypes and genotypes.
**Report** accurate records of observations and investigations.
**Organize** data into tables and charts and interpret them.

Part 1 - Diptera Island
Students beginning this part of the curriculum unit should:
- be familiar with the structure and function of DNA
- be able to differentiate between dominant and recessive traits
- be familiar with Mendel's laws of segregation and independent assortment
- have an understanding of Punnett squares
- be able to calculate percentages
- be able to differentiate between a chromosome, gene and allele

Part 2 & 3 - Diptera Island
Students beginning this part of the curriculum unit should:
- be able to identify a problem or a question central to scientific investigation
- be able to understand the purpose of a hypothesis and to formulate one
- be able to collect and evaluate data

## State Standards

The Massachusetts Department of Education Science and Technology/Engineering Curriculum Framework is based on 10 guiding principles; many of these are addressed in this curriculum unit.
http://www.doe.mass.edu/frameworks/scitech/2001/principles/prin_1.html

Specifically the unit addresses Genetics > The Chemistry of Life > Grades 9-10 > Strand 2: Life Science (Biology) of the Science and Technology/Engineering Learning Standards, PreK-High School.
http://www.doe.mass.edu/frameworks/scitech/2001/standards/ls9_103.html

# BioControl Genetic Decoder Device Instructions

## Decoding the Genome (for teachers)

The goal is to live as long as possible and reproduce the most robust species of *Musca carniverousa*. The ability to survive and reproduce is influenced by the genome so figuring out what the genes stand for is critical in survival. After turning on the decoder use the stylus to click on "Genetics". Start the device by entering your name in the start screen. If you know graffiti use that to enter your name, otherwise click on the small "abc" at the bottom of your screen and a miniature keyboard will apear. It is critical that everyone start the decoder at the same time, so after entering your name, wait for the rest of the class to start. **(teachers may want to give a prompt to begin)**. When it starts you'll see that you have a sequence of five genes (by default). Each of the genes stands for a trait. The shading of the genes (solid, striped and clear) determines if the gene is homozygous, heterozygous, dominant or recessive **(students will need to figure out which symbol represents which condition)**. Your current age (which will constantly increase), generation, and total score are also displayed

You can mate with other flies by lining up your decoder and having ONE person hit the Mate button (one person is the sender and the other is the receiver). At this point you will either get a confirmation that the mating was successful or a message saying that you were unable to mate. If you successfully mate, each of the parents will disappear and be randomly replaced by one of their offspring. You can think of these organisms as breeding in discrete generations. After the parents reproduce once, they die. When you reproduce successfully and become one of the offspring, your age will go back to zero, your generation will increase by 1 and your score will increase by whatever you age was at the time plus a bonus (age 21-40 = 5 points, age 41-60 = 10 points, age 60+ = 20 points).

When you die, you will receive a message that tells you the age of death, your score and your current generation. At this point you have the option of looking at the data from this round (the matings and resulting offspring) or starting a new round. **(Students can begin a new round at anytime. As each round progresses, students should start to see some patterns. Encourage them to form a stategy to decode the data -- see "more information for instructors" for more tips.)**. When playing the game, you may look at your data at any point or if you don't want other people to meet you, you can press the READY button, which will toggle to say LOCKED. In this mode you can neither send or receive meetings.

## Game Parameters

The basic parameters that you set here are which genes are active and what they stand for. Gender is required, but the others are optional. The other genes are as follows:

- Longevity - live to age 50 or 80
- Childhood Disease - kills you at age 13
- Aging rate - age at the two different specified rates (see rates at the side)
- Fertility - whether you can reproduce to age 50 or 80

You can also enable junk genes at positions 1, 4 and 6 that don't code for anything.

# More Information for Instructors

While it may seem like this game requires a great breadth of genetics knowledge, it actually does not. Instead, it emphasizes deep basic understanding of genetics concepts as well as solid understanding of experimental methodology. The colors of the genes have the following meaning:

- **Solid (dotted)** = Homozygous Dominant (AA)
- **Clear** = Homozygous Recessive (aa)
- **Striped** = Heterozygous (Aa)

The default meaning for the genes are as follows:

- **Gene 0** - Gender – you cannot mate with someone of your same gender (AA = female, Aa = male)
- **Gene 1** - Longevity – how many "years" before you die (AA/Aa = 80, aa = 50)
- **Gene 2** - Childhood disease – if you have this recessive gene (aa), you die at age 13 (regardless of your Gene 1 genotype), AA/Aa means that you have no disease (when you start a new game, you have a 10% chance of getting the disease initially)
- **Gene 3** - Aging rate – how many seconds in real time corresponds to a year in game time (AA/Aa – 3 seconds, aa – 1 second)
- **Gene 4** - Fertility – the maximum age that you can still mate – as soon as you reach this age, you are deemed infertile and can no longer mate (AA/Aa – 80, aa – 50)

The genotype of each gene (AA, Aa, aa) is assigned randomly when the player starts a new game (according to these rules: AA – 25%, Aa – 50%, aa – 25%, except for the childhood disease gene, which aa = 11.11%, Aa = 44.44 %, AA = 44.44 % since childhood diseases are much more rare but more detrimental than the other genes).

In playing the game, we usually just start the first round with the instructions on how to work the game and to get as many points as possible (remember when you die you lose all of your points). By the end of the round the game has quickly transformed into trying to figure out what the genes stand for. So after the first round we usually ask what they have figured out so far and what they would like to know. For the second round we don't coerce them too much to focus on anything in particular, but we do give them a data sheet which is just a blank sheet that has three columns saying *Parent 1*, *Parent 2* and *Result*, where result can be anything from the resulting phenotype, mating capability, or age of death. If students are struggling at this point, encourage them to make a datasheet. Something similiar to the "Generation Datasheet" could work well.

As rounds progress we sometimes start subtly focusing the group on particular traits. The traits were designed to have some that are easy to figure out and some that are more difficult. The order of intended difficulty (from easiest to hardest) is gender, childhood disease, longevity, aging rate and fertility. As with all of the games, the fun comes from figuring this out, so less is more. When you guide a group towards a particular trait, do it carefully. Suggest a question like "What might prevent two organisms of the same species from mating?" -- at this point you can direct them to the "Diptera Island Experimental Archive" sheet. This worksheet should help guide them through the steps of designing an experiment.

There are a lot of great genetics and experimental design questions that come out through this activity. The difference between phenotype and genotype is a big point of discussion as are topics on mating crosses, data collection, population genetics (which are not modeled explicitly here), and probability.

# Extensions and Web Resources for Diptera Island Curriculum Unit

**The Human Genome Project (http://www.genome.gov/)**
Utilize web resources to understand the human genome project. What does this mean to individuals? What are the ethical and moral issues surrounding the mapping of genes?
In the past few months news agencies have reported about an initiative to implant humans with a chip that carries a number that corresponds with their medical history – much like chips for animals that give the identity of their owners. The doctor or health professional would be able to scan the chip and then use the number or code to look up health information. What would be the implications of having a scanning chip that revealed your entire gene code (genome)?

**View the Movie Gattaca**
Have students view the movie (or portions of) Gattaca, starring Ethan Hawke. Find info about the premise of the movie here
http://movie-reviews.colossus.net/movies/g/gattaca.html
An excerpt from site……

"*Welcome to the 21st Century, an era when things aren't that much different, but people are. No longer is standard procreation the accepted way to reproduce. Consider all of the birth defects that such an approach can bring about. And, while it would be unreasonable to outlaw sex for the purpose of producing offspring, be aware than any children so conceived are almost certain to be "in-valids" — genetically imperfect and ill-suited to be productive members of society. There is a better, more rational way — a method that will guarantee health, stamina, and physical attractiveness. Let science do a little tinkering with the DNA. Everyone does it. Or at least everyone who wants their child to have a shot at a normal, well-adjusted life.*

*This is the chillingly feasible premise of Gattaca."*

Blazing a Genetic Trail: Stalking a Lethal Gene (cystic fibrosis)
http://www.hhmi.org/genetictrail/a100.html
Blazing a Genetic Trail: HOW GENETIC DISORDERS ARE INHERITED:
Dominant Disorders: A Fifty-Fifty Chance
http://www.hhmi.org/genetictrail/e100.html
Blazing a Genetic Trail: The Human Genome Project
http://www.hhmi.org/genetictrail/c100.html
Family history as a tool for public health and preventative medicine: A pubic health perspective (includes case studies)
http://www.cdc.gov/genomics/info/perspectives/famhistr.htm

BIOL 121 Human Genetics References - A large list of useful links
The Debate over Dominance - A must read
Genetics Glossary
Genetic Science Learning Center - Provides information to help people understand genetics affects their lives and society
DNA from the Beginning - "An animated primer on the basics of DNA, genes and heredity"
Recessive and Dominant Inheritance
WNET School - Genes at work - dominant traits and inheritance
Genetics Education Center - Extensive resources
Introduction to Mendelian Genetics - The storage and transmission of genetic information
Morgan: A Genetics Tutorial - Requires software to be downloaded - well worth registering