LAB: Evolution of Chocolate Candies

If you've ever stood at the grocery store checkout line and seen the vast array of chocolate candies that are available for people to purchase, you may have wondered: "How did there get to be so many different kinds of candy?" Ask your parents—chances are good that when they were growing up, there were only a limited few types of chocolate candy that were around to tempt their taste buds. Now, there are literally dozens and dozens of chocolate candies to choose from.

In this activity, you will construct a phylogenetic tree and a cladogram, both of which are tools that evolutionary biologists use to derive and examine relationships between and among species of similar organisms. You will need to put on your critical thinking and analysis hat for this activity, because sometimes there is more than meets the eye when looking at what makes two groups of organisms (or in this case, candies) alike or different!

You and your partner will be given a baggie containing a variety of chocolate candies. With the candies in the bag, you will create **both** a phylogenetic tree and a cladogram that both demonstrate the evolutionary history of the kingdom *Mellitus*. Your activity should include the following information (to be placed in your lab notebook):

1. A **phylogenetic tree** showing the **speciation** of candy over time. The rest of your report will depend on the classification you create in this tree, so make sure you have good reasons for your placements. You may or make your classification based on morphology (the physical form of the candy), internal structure, development, DNA/carbohydrate sequence, or any other basis, as long as you can justify it scientifically.
2. A **cladogram**, including a matrix that shows how characteristics were arranged to separate one group of candies from the next. We will discuss in class how cladograms are made.
3. **Kingdom, phylum, genus and species names** for your candies. Assume that all species featured in this lab are members of the same **kingdom**, but it is up to you to decide on the rest of the Linnaean classification.
4. **A written explanation of your tree**, containing the following parts:
    a. The particular environments that **five** of the species are adapted to, and the adaptations that enable the species to thrive.
    b. Homologous structures (two examples)
    c. Vestigial organs (two examples)
    d. Extinction with a reason (two examples)
    e. **This explanation must be written individually.** Lab partners may **NOT** have the same explanations for the trees/cladograms they come up with together.

Use a Latin dictionary to come up with species names. *Mellitus* is from the Latin word for "sweet" or "honey".

SAFETY CONSIDERATIONS: If you are allergic to peanuts or tree nuts, do NOT consume any part of the lab. Alert your teacher immediately.

Available candies you <u>may</u> have in your bag are:

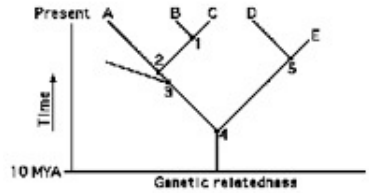
***NOTE**: You may not have all of the candies below; you will have a sample of 10 different specimens.*

Hershey's Kisses	Snickers	Milky Way	Baby Ruth	Twix
Krackel	Three Musketeers	Mint Three Musketeers	Mr. Goodbar	Reese's Peanut Butter Cups
Rolo	Special Dark	Milky Way Midnight	Snickers Dark	Hershey Bars

You will also have plastic knives and paper plates available to you for examining specimens so that you can investigate the physical characteristics of each specimen.

How should I get started?: A couple of pointers

1. **Make a list of the main ingredients of each candy type**. As evolutionary biologists gather and analyze data from various sources to construct phylogenetic trees, so too must you collect data about your specimens! For example, Snickers bars are made of milk chocolate, nougat (the gooey stuff in the middle), caramel and peanuts. It is not necessary to read the package label to determine what these ingredients are—we just want basic information. This information will also help you to determine what characteristics to include in your matrix when making your cladogram. Knowing what each candy is made of will also help you to determine what relationships the candies have to one another. It will be helpful to place this information into a chart of some kind for organizational purposes.
2. **When constructing a phylogenetic tree, remember, there must be a root.** In other words, there is a single common ancestor to all the members in the tree. For example, look at this sample tree:



Notice how there is a root (at the bottom) and then there are branches away from it. The further away from the root a branch is, the more time has passed since the two species have diverged away from one another. Each branching point (for example, #4) represents a **node**, or a common ancestor. The further away a specimen is away from the root of the tree, the more changes have occurred since the ancestor appeared, and thus the more UNLIKE the ancestor the distant specimen is. Essentially, you want to do the following:

a. Once you have generated your ingredients list, figure out among candy types which specimens you have that have common ingredients.
b. Then, figure out which ones have the most in common. These will be the specimens most closely related to the root ancestor.
c. As you find that specimens have less and less in common, they will be more distant from each other on the tree. Place your specimens accordingly.

Be **creative**, but be sure that what you come up with is **plausible**. Remember, you must use evidence to justify the placement of your specimens on the tree you construct.