Lab: <u>Genetic Variation within Populations</u>

Part 1: Genetic variation in a human population (Large Group)

Introduction

Natural selection is the mechanism for evolution; Charles Darwin first introduced this concept in 1859. In general terms, natural selection refers to a change in populations that results from certain organisms contributing more offspring to the population than other organisms of the same species.

There are 3 major requirements for evolution to occur by natural selection:

(1) Variation - individuals within a population show differences in their characteristics

(2) Heredity - characteristics are heritable, which means they are passed on from parents to offspring

(3) Differential survival and reproduction - individuals with certain characteristics survive longer and reproduce more offspring than other individuals with different characteristics.

Individual organisms within a population have a variety of genetic traits. Most characteristics (traits) in an organism are controlled by multiple genes (polygenic). However, there are also examples where characteristics are determined by the presence or absence of a particular allele of a single gene. See the descriptions for these traits below:

- Widow's peak. This is an obvious, sharp dip in the hairline at the center of the forehead, and results from a dominant allele (W). People that lack a widow's peak are double recessive (ww).

- Attached earlobe. The earlobes of some people hang free (EE or Ee)) whereas for others the earlobes are attached directly to the head. The latter condition occurs in people that are double recessive (ee).

- Tongue rolling. People that possess the dominant allele R can roll their tongue into a U-shape. People that are double recessive (rr) cannot roll their tongue.

- Hair form. Wavy hair results from the interaction between the allele for curly hair (C) and the allele for straight hair (s). People that are homozygous dominant (CC) have curly hair. People that are heterozygous (Cs) have wavy hair. People that are homozygous recessive (ss) have straight hair. Wavy hair form is an example of incomplete dominance.

- Hitchhiker's thumb. Bend your thumb backward as far as possible. If you can bend the last joint of your thumb to an angle of 60 degrees or more, you are double recessive (hh). If you are not able to bend your thumb to this extent, you possess the dominant allele (H).

- Interlocking fingers. Behavioural traits may also have a genetic basis. People that almost invariably fold their hands with their left thumb over their right thumb have the dominant allele F. People that place their right thumb over their left thumb are double recessive (ff).

- Bent little finger. Hold your two hands together with your little fingers side by side (palms facing you). If the last joints of the little finger diverge (are separated), you have the dominant allele B for bent little finger. If your fingers are straight and in contact at the tip, you are double recessive (bb).

- Mid-digital hair. Some people have hair on the middle (second) joint on one or more of their fingers. People with complete absence of hair are double recessive (mm). The presence of any hair in this region is due to the presence of the dominant allele M.

Procedure:

1. Examine the human traits described above that are determined by a single gene and classify yourself according to your phenotype for eight different traits on Table 1 found on the data collection sheet.

2. With your entire group compare your data for each of the phenotypes. Record the group members totals on Table 1.

Part 2: Natural Selection Under Selective Predation (Small Group)

Introduction

In your group you will investigate changes in the genetic composition of a population that is under a selective pressure. Through the simulation you will observe the evolution of protective colouration in a population of "beads" that is experiencing natural selection through ***selective predation***. The predation (eating) of seeds by birds; is an important selective pressure.

The most common colouration phenotypes in many populations are those that stand out the least against the prevailing background in their environment. Those individuals whose colour and pattern do not match their habitat (do stand out more) will suffer predation and will be removed from the population. You have been supplied with a quantity of coloured beads, and a patterned cloth that represents an environment with various background colours.

Environment 1

Procedure:

1. Collect a coloured piece of material, a cup with 12 of each of the 10 colours of beads provided (for a total of 120 beads). This population of seeds has been recorded on your lab data sheet as "Generation 1" under Table 2.

2. Spread the patterned cloth out on your table and, after shaking the cup of beadsr to mix up the coloured beads, spread the beads over the whole cloth randomly.

3. You and your group members will serve as the predators in this exercise (i.e., seed-eating birds). Birds have vision that is very similar to that of a human and in many ways their behaviour is similar. We will turn off some overhead lights and your group will begin picking up the seeds one at a time until your group has collected a total of 80 seeds. When searching for the seeds move your eyes in a circular search pattern. This overcomes the problems of picking the seeds up in clusters. Each student in the group should only pick up their share so that the element of competition is removed (i.e., in a group of 4 students select 20 seeds each - if there are 3 students in the group, 2 students pick up 27 seeds and one student picks up 26 seeds), etc.

4. Discard the collected seeds into the cup labeled "eaten". The collected seeds are considered to have been eaten and thus removed from the population; they do not contribute their genes to the next generation.

5. Recover the remaining 40 seeds once predation has reduced the population by 2/3 (80 seeds). Carefully fold and lift your cloth to recover the survivors. Count the seeds to ensure that you have 40 survivors and sort these seeds by colour.

6. For each surviving seed you must add 2 more of the same colour to the population to represent reproduction of offspring in the next generation. For example, if 3 blue seeds survived predation, you add 6 more for a total of 9 blue seeds (three "parents" + six "offspring"). This represents reproduction and returns the total number in the population to its original level of 120 individuals. Note that the composition of phenotypes in the population (i.e., colours) will probably be somewhat different from the original population due to the effects of predation. Record the numbers of each colour after reproduction (3 x the number that survived) on your lab sheet as "Generation 2". Please ensure that the total number of individuals is 120.

7. Spread these seeds over your cloth once again and repeat the process of preying on your seed population. Allow the 40 survivors to reproduce once again (Steps 3 to 6) in order to determine the phenotype composition of the 3rd generation. Record your results on the datasheet.

Environment 2

Procedure:

8. After you have completed Step 7 above, exchange your cloth (Environment #1) for the blue cloth (Environment #2). Use your population of 120 seeds to carry out 2 more rounds of predation and reproduction (Steps 3 to 6 above). Be sure to record on your lab sheet the final results.

9. Compare your final results with one other group of students and write their results in table 3 on the data collection sheet.