28 AN EXERCISE TO DEMONSTRATE THE ROLE OF NATURAL SELECTION IN EVOLVING ADAPTATIONS

28.1 INTRODUCTION

In unit 11 and 12 of LSE-07 Course (Taxonomy and Evolution) you have learnt about the role of natural selection in the evolutionary process. You have studied that in a population natural selection promotes those alleles that confer an adaptive advantage on the individuals who possess such alleles. We further discussed in unit 11 and 12 of the LSE-07 course, the examples of *Biston betularia* and sickle-cell anemia to illustrate the positive role played by natural selection in evolving adaptations. You may recall that in England the melanic (dark coloured) forms of *Biston betularia* resting on soot covered trees increased in numbers in post-industrial revolution period while the number of non-melanics was higher in pre-industrial revolution times when the trees were lichen covered. The reason is that the melanics easily escaped predation in an environment to which they were adapted best. Natural selection promotes in a population those characters that are better adapted to the environment. African populations maintain the sickle cell allele in heterozygous condition (Hb^A/Hb^A — normal homozygous genotype, Hb^A/Hb^S-heterozygous genotype and Hb^S/Hb^S sickle cell genotype). The heterozygotes do not contract either malarial disease or sickle cell anemia. They are better adapted to live in an environment in which both the killer diseases are prevalent. In this simple exercise you will learn the probable role of selection process in evolving meaningful adaptations in a population.

Objectives

This exercise will enable you to:

- make use of simple devices to illustrate the concept of natural selection
- discuss that evolution of adaptations is a non-random process
- relate the illustration presented here to real-life situations.

28.2 MATERIALS REQUIRED

1. white card-board squares of side 2 cm - 260 pieces.
2. plastic bowls-2.

28.3 PROCEDURE

You require 260 white card-board squares of 2 cm side, 10 for each of the 26 alphabets. This means you have with you 10 As, 10Bs, 10Cs and so on upto 10Zs. You have 260 letters with you.

Situation I

1. Leave all the 260 cards in a plastic bowl; mix well. Your task would be to pick out any three cards at a time and get a meaningful word, let us say CAT.
2. If you do not get the word CAT, discard the three cards into another bowl. You continue to do this exercise until you get the required word. You will find that the three letters C, A and T shortly disappear without the word CAT being formed. Instead, you may form all types of meaningless combinations such as ALC, TXP, BYA, so on and so forth. After 86 draws, the bowl is almost empty with only two cards lying there and the word CAT not yet formed. Barring a miracle, you may not get the requisite word even after hundreds of such a draw.

Situation II

Now let us have the rules of the game slightly changed. When you make your draw of three letters and when any of the required letters C, A and T appear in any combination, return these letters to the bowl and discard only the other letters. Assuming you draw XAP, return A to the bowl and put aside P and X. Or, if you draw TUC return T and C to the bowl and put aside U. By this process, the letters C, A and T will start accumulating in the bowl, even as the other letters are gradually lost. Sooner you will have 10Cs, and 10As and 10Ts in the bowl. Naturally, the meaningful word CAT will be picked up in a few draws. Record the number of draws you have made to get the right word.

Situation III

Now let us introduce yet another change in the rules of the game. When you draw three letter combinations such as QTC, AWT etc., discard the non-essential letters such as Q and W as you did earlier. But before returning the essential letters back to the bowl, clip them together. Use a gem clip for this purpose. Thus T and C will be clipped together and so also the letters A and T. Now when you draw the word CAT from the bowl, you will succeed in doing so in less number draws. Record this observation also.

28.4 INFERENCE

What do you infer from the above three situations? In situation I, the natural selection is not operating. The letters C, A and T do not have any special advantage over the other letters. As a result the meaningful word CAT or the adaptation is not emerging.

In situation II, natural selection is operating. The letter C, A and T which contribute to the adaptation are retained in the population. In other words, the three letters are favoured more than the rest of the alphabets. The fact that you return the three letters to the bowl symbolises the retention of the adaptation in the population. Under the influence of natural selection, a meaningful adaptation (here the meaningful word CAT) emerges.

In situation III, you clip together the two essential letters as and when they are picked up (such as C and T, and A and T). This clipping together signifies another process that naturally occurs in the population—a natural genetic phenomenon known as **inversion.** Recall from your studies of LSE-03 (unit 9 of block 2) that inversions are suppressors of crossing over. Inversions therefore hold together adaptive genes in a tight linkage. The two letters C and T or A and T clipped together represent linked genes and are prevented from recombining with other letters.

1. What do the three situations considered together signify?

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2. Why are inversions regarded assuppressorsof crossing over event?

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