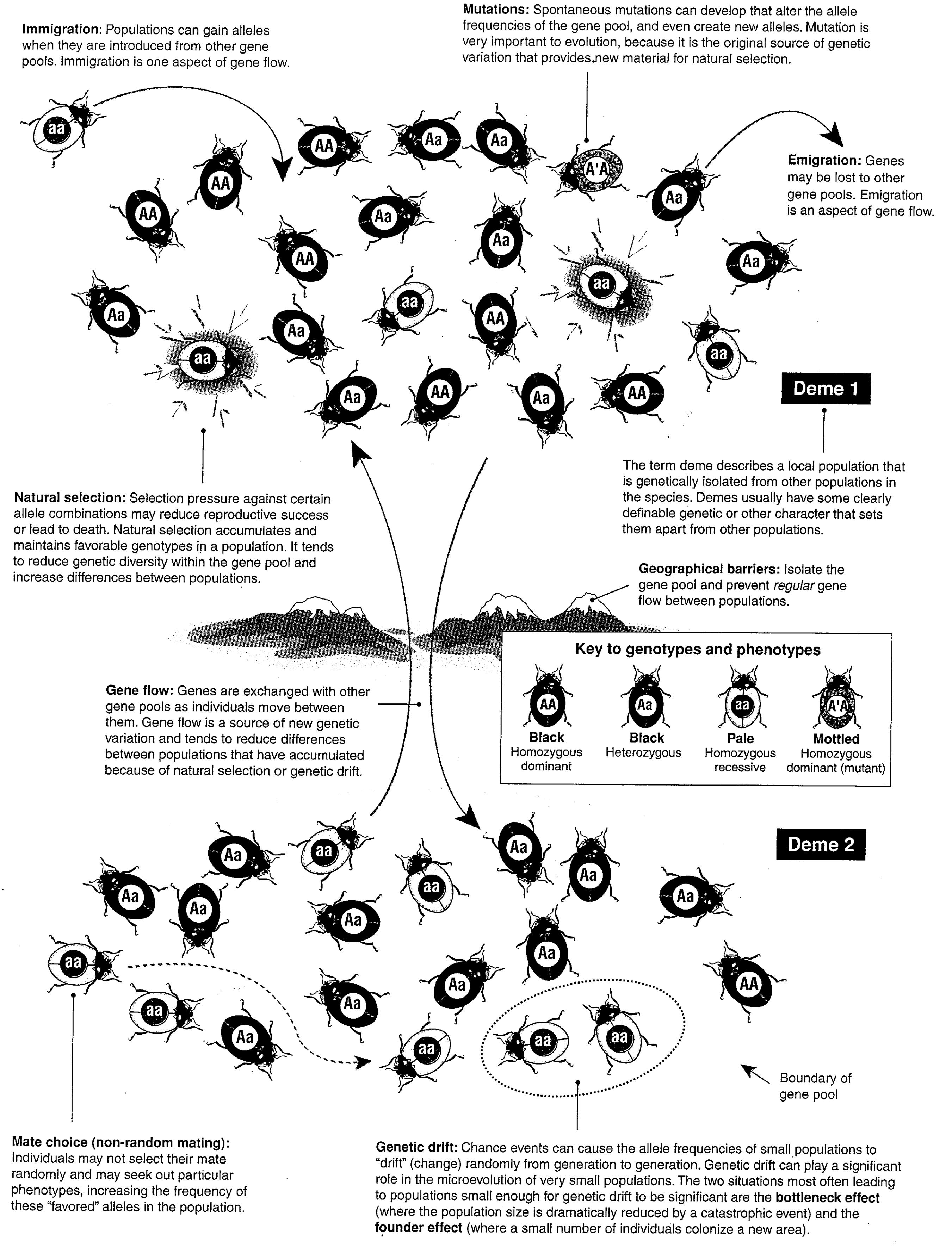
Gene Pools and Evolution

This activity illustrates the dynamic nature of **gene pools**. It portrays two populations of one hypothetical beetle species. Each beetle is a 'carrier' of genetic information, represented here by the alleles (A and a) for a single gene that controls colour and has a dominant/recessive inheritance pattern. There are normally two phenotypes: black and pale. Mutations may create other versions of the phenotype. Some of the microevolutionary processes that can affect the genetic composition (**allele frequencies**) of the gene pool are illustrated. See *Gene Pool Exercise* for cut-out beetles to simulate this activity.



1. For each of the two demes shown on the previous page (treating the mutant in deme 1 as a AA):

   (a) Count up the numbers of **allele types** (**A** and **a**).

   (b) Count up the numbers of **allele combinations** (**AA, Aa, aa**).

2. Calculate the frequencies as percentages (%) for the allele types and combinations:

Deme 1		Number counted	%
Allele types	A		
	a		
Allele combinations	AA		
	Aa		
	aa		

Deme 2		Number counted	%
Allele types	A		
	a		
Allele combinations	AA		
	Aa		
	aa		

3. One of the fundamental concepts for population genetics is that of **genetic equilibrium**, stated as: *"For a very large, randomly mating population, the proportion of dominant to recessive alleles remains constant from one generation to the next".* If a gene pool is to remain unchanged, it must satisfy all of the criteria below that favour gene pool stability. Few populations meet all (or any) of these criteria and their genetic makeup must therefore by continually changing. For each of the five factors (a-e) below, state briefly **how** and **why** each would affect the allele frequency in a gene pool:

   (a) Population size: ______________________

   ____

   ____

   ____

   (b) Mate selection: ______________________

   ____

   ____

   ____

   (c) Gene flow between populations:

   ____

   ____

   ____

   (d) Mutations: ______________________

   ____

   ____

   ____

   (e) Natural selection: ______________________

   ____

   ____

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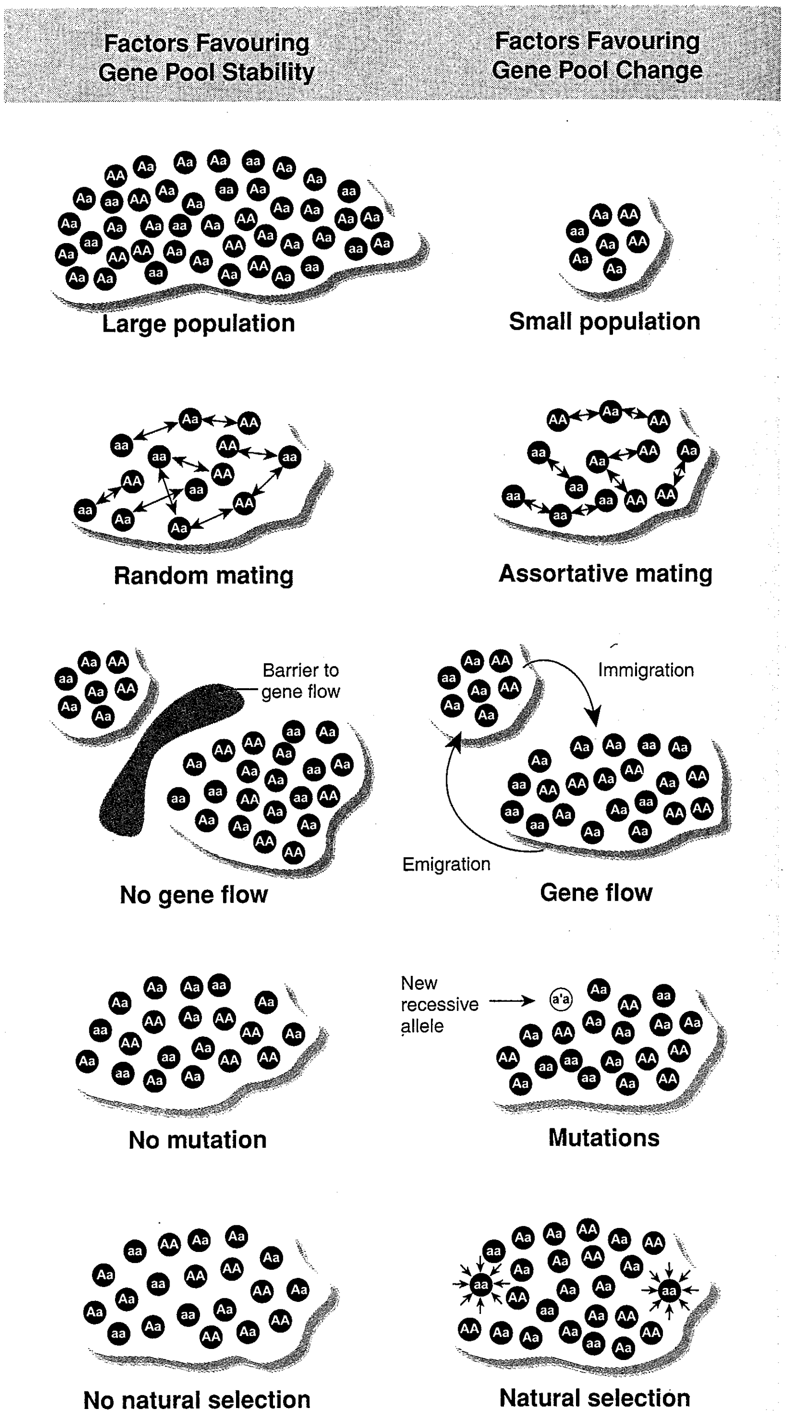

4. Identify the factors that tend to:

   (a) Increase genetic variation in populations:

   ____

   ____

   (b) Decrease genetic variation in populations:

   ____

   ____

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Changes in a Gene Pool

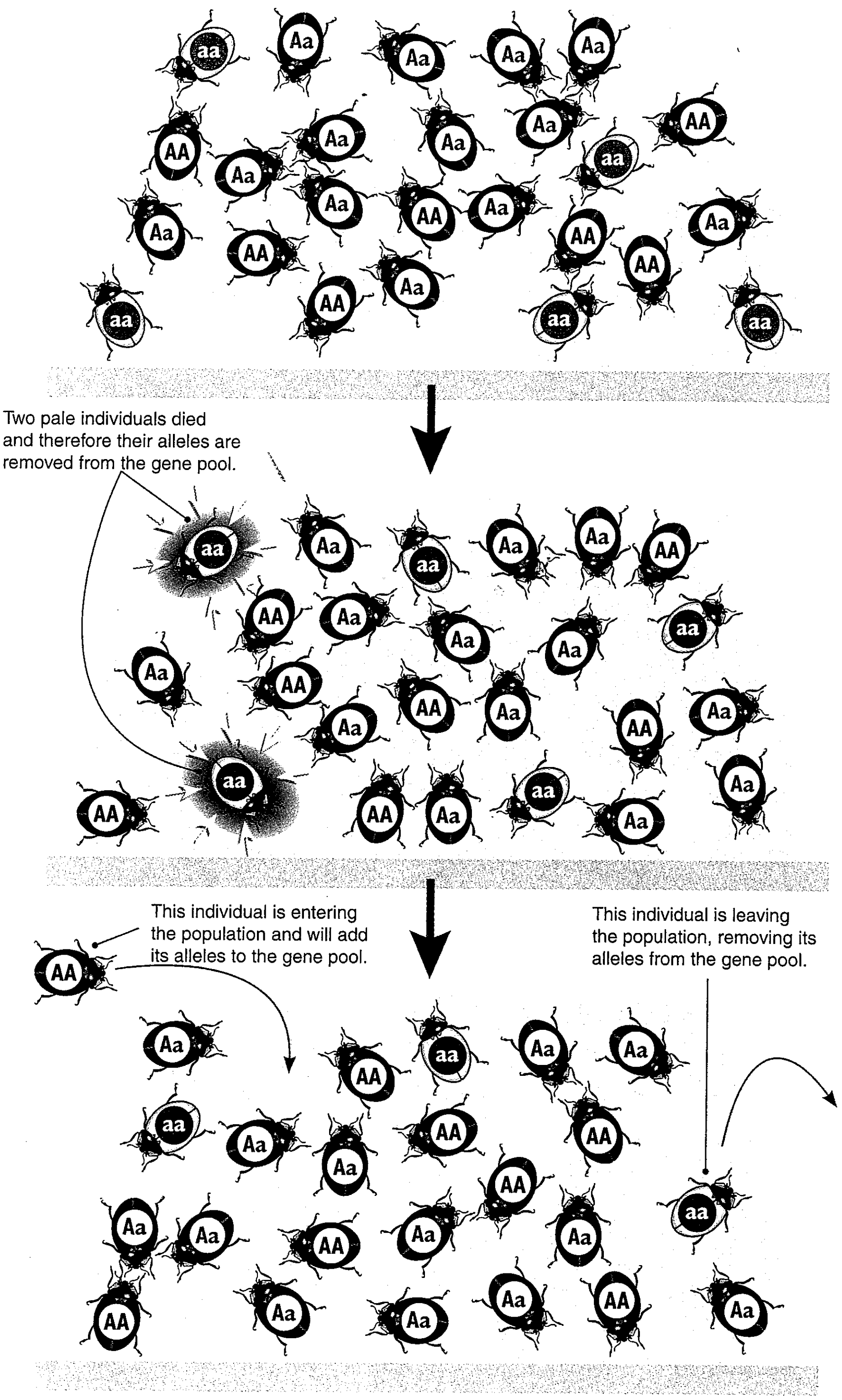
The diagram below shows an hypothetical population of beetles undergoing changes as it is subjected to two 'events'. The three phases represent a progression in time (i.e. the same gene pool, undergoing change). The beetles have two phenotypes (black and pale) determined by the amount of pigment deposited in the cuticle. The gene controlling this character is represented by two alleles **A** and **a**. Your task is to analyse the gene pool as it undergoes changes.

Phase 1: Initial gene pool

Calculate the frequencies of the allele types and allele combinations by counting the actual numbers, then working them out as percentages.

	A	a	AA	Aa	aa
No.	27		7		
%	54		28		

Allele types (A, a) — *Allele combinations* (AA, Aa, aa)



Phase 2: Natural selection

In the same gene pool at a later time there was a change in the allele frequencies. This was due to the loss of certain allele combinations due to natural selection. Some of those with a genotype of aa were eliminated (poor fitness).

Calculate as for above. Do not include the individuals surrounded by small white arrows in your calculations; they are dead!

	A	a	AA	Aa	aa
No.					
%					

Phase 3: Immigration and emigration

This particular kind of beetle exhibits wandering behaviour. The allele frequencies change again due to the introduction and departure of individual beetles, each carrying certain allele combinations.

Calculate as above. In your calculations, include the individual coming into the gene pool (AA), but remove the one leaving (aa).

	A	a	AA	Aa	aa
No.					
%					

1. Explain how the number of dominant alleles (A) in the genotype of a beetle affects its phenotype:

2. For each phase in the gene pool above (place your answers in the tables provided; some have been done for you):

   (a) Determine the relative frequencies of the two alleles: A and a. Simply total the **A** alleles and **a** alleles separately.
   (b) Determine the frequency of how the alleles come together as allele pair combinations in the gene pool (AA, Aa and aa). Count the number of each type of combination.
   (c) For each of the above, work out the frequencies as percentages:

Allele frequency = No. counted alleles ÷ Total no. of alleles x 100

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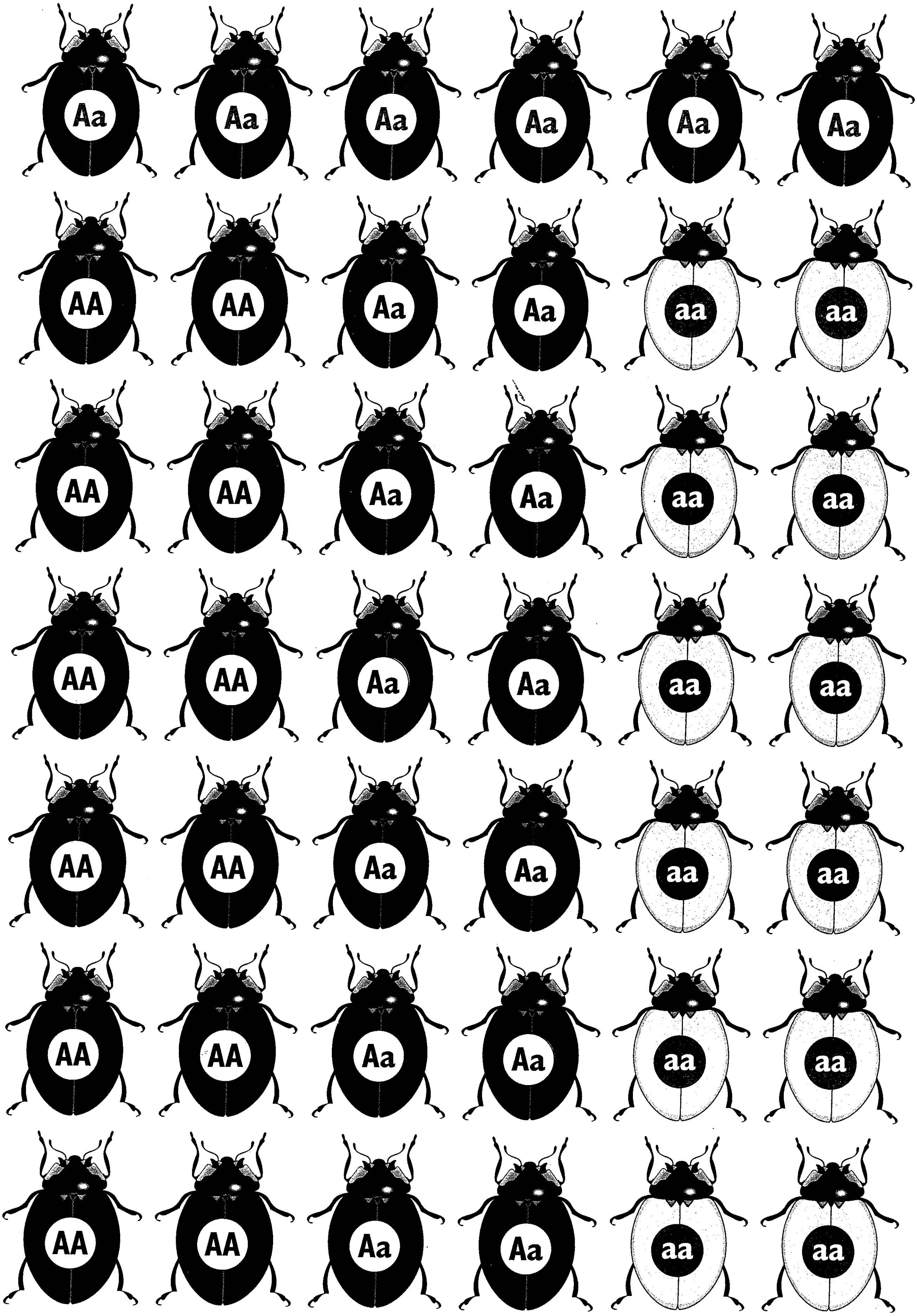
Related activities: *Gene Pool Exercise, Natural Selection*
Weblinks: *Natural Selection in Populations*

Gene Pool Exercise

Cut out each of the beetles on this page and use them to reenact different events within a gene pool as described in this topic pages: *Gene Pools and Evolution, Changes in a Gene Pool, The Founder Effect, Population Bottlenecks, Genetic Drift.*



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