can be modified to have similar functions. The SAS gene can be modified to produce the AFPIII protein and also shows ice-binding capabilities. These features provide evidence that the AFPIII gene was the result of diversification of function following duplication of the SAS gene in eelpout.

81. An Introduction to Evolutionary Processes (page 111)

1. (a) **Gene flow**: The movement of genes between populations of the same species (demes) as a result of migration.
   (b) **Genetic drift**: The change in a population's allele frequency as a result of chance events. Genetic drift is random, so is not related to phenotypic fitness.
   (c) **Natural selection**: The differential survival and reproduction of favourable phenotypes (favourable phenotypes become more common in subsequent generations). Natural selection always operates in the prevailing environment, so the favourable phenotype can shift when conditions (selection pressures) change.
2. (a) **Population size**: Large population acts as a 'buffer' for random, directional changes in allele frequencies. A small population can exhibit changes in allele frequencies because of random loss of alleles (failure of an individual to contribute young to the next generation).
   (b) **Mate selection**: Random mating occurs in many animals and most plants. With 'mate selection', there is no random meeting of gametes, and certain combinations come together at a higher frequency than would occur by chance alone. This will alter the frequency of alleles in subsequent generations.
   (c) **Gene flow between populations**: Immigration (incoming) and emigration (outgoing) has the effect of adding or taking away alleles from a population that can change allele frequencies. In some cases, two-way movements may cancel, with no net effect.
   (d) **Mutations**: A source of new alleles. Most mutations are harmful, confer poor fitness, and will be lost from the gene pool over a few generations. Some may be neutral, conferring no advantage over organisms with different alleles. Occasionally, mutations may confer improved fitness and will increase in frequency with each generation, at the expense of other alleles.
   (e) **Natural selection**: Selection pressures will affect some allele types more than others, causing allele frequencies to change with each generation.
3. (a) Increase genetic variation: Gene flow (migration), large population size, mutation.
   (b) Decrease genetic variation: Natural selection, non-random mating (mate selection), genetic drift.

82. Genetic Drift Affects Gene Pools (page 113)

1. (a) Genetic drift causes random fluctuations in the allele frequencies in a population.
   (b) Genetic drift has the same effect as sampling error, i.e. it is greater when the size of the sample (population) is small. In a small population fluctuations in allele frequencies will be greater, which can lead to alleles becoming lost or fixed.
2. (a) Genetic drift would decrease the number of heterozygotes.
   (b) This can lead to loss of alleles and a reduction in genetic diversity. In the long term, small populations may have insufficient genetic diversity to adapt to environmental changes.

83. Adaptations and Fitness (page 114)

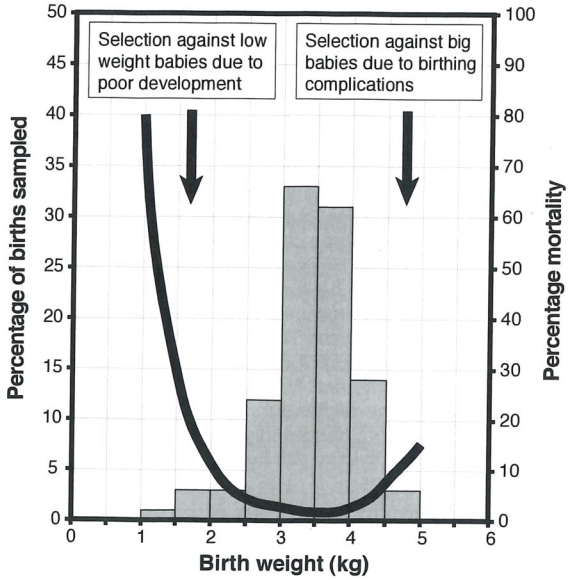
1. Adaptation is the process by which populations evolve heritable traits (adaptations) that improve fitness in their environment. Adaptations are the product of evolution and may be structural, behavioural, or physiological traits that maximise survival and reproduction of the organism.
2. The rise of the Southern Alps, which separated the proto-kaka population into two.
3. The kaka and kea, after ~3 my of separation, have evolved adaptations that exploit available food resources in contrasting environments. The kea's is highly intelligent, inquisitive, and opportunistic which is adaptive in an environment where food is scarce and all potential food sources should be investigated. Its large beak and claws are well adapted to tackling an extremely wide variety of foods (including living sheep). The kaka's adaptations are more closely associated with the forest environment. It has a brush-like tongue for collecting nectar and is agile in the branches so that it can cling and feed simultaneously. Its beak is well adapted to exploiting many different forest foods, including opening kauri cones to extract the seeds and digging out insects, and it can identify and process a wide range of forest foods, switching as different foods become available seasonally.

84. Natural Selection Affects Gene Pools (page 115)

1. (a) Stabilising selection: Selection maintains the status quo. Phenotypes at the extremes of the current phenotypic mean are eliminated.
   Stable environment and resources.
   (b) Directional selection: Selection that eliminates phenotypes at one end of the phenotypic range and shifts the adaptive phenotype in one direction so that a new phenotypic norm is established.
   Steady environmental trend (change in one direction, sometimes regionally).
   (c) Disruptive selection: Selection that favours extremes of phenotype in the one environment and eliminates 'mid-range' phenotypes. Leads to two new phenotypic means. Favoured in an environment where there is diversification of habitats or resources in the one place.
2. Fluctuating environments are more likely to provide resource instability (e.g. food shortages), which may favour diversification of phenotypes to exploit extremes of the resource range. For example, droughts may lead to seed shortages, so birds may be forced to exploit seeds outside the range of sizes they would normally eat (either small or large seeds), as occurred with the finches on Santa Cruz.

85. Stabilising Selection for Human Birth Weight (page 116)

Plot based on the sample data provided in the appendix.



Note: Weight categories should not overlap. The data should be sorted into weight classes of: 0.0-0.49, 0.50-0.99 etc.

1. Normal distribution (bell-shaped curve), probably with a skew to the left.
2. 3.5 kg (taken from the table: only 2% mortality)
3. Good correlation. Lowest frequencies of surviving birth weights correspond to birth weights of highest mortality.
4. Selection pressures operate at extremes of the range:

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