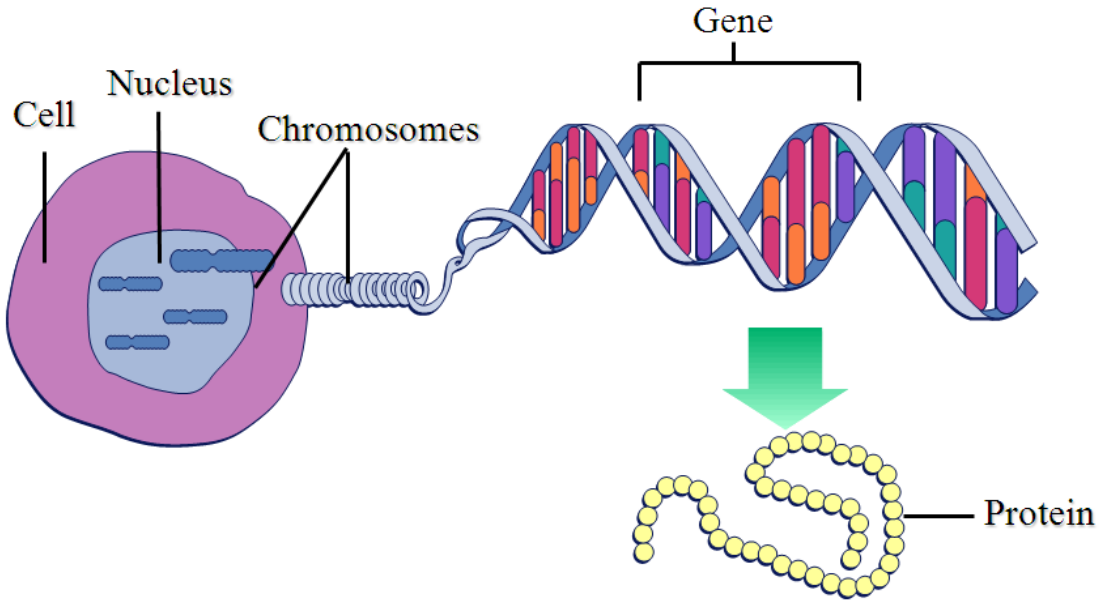
Genes, Evolution and Environment

Genes

Genes are the physical and functional units of heredity which are made up of DNA (deoxyribonucleic acid) and are located on chromosomes; structures which are found in the nucleus of every living cell in the human body. The basic elements of DNA include the four bases: adenine, thymine, cytosine and guanine. Genes can vary in size from a few hundred of these DNA bases to more than 2 million bases. The sequence of these DNA bases (a specific gene) code for the synthesis of one of many proteins that are necessary for human function (see figure below). Best estimates put the number of genes in humans at around 25,000. Many genes alone or in combination with other genes contribute directly to particular human traits, such as eye colour, height, and susceptibility to certain diseases.



1) If we all have the same genes that virtually result in the same function, how is it that each individual human being is unique?

Evolution

Evolution is the change in the frequency of genes within a population over several generations. Changes in the gene frequency directly influence the traits and characteristics of a species, and if large enough, can result in the formation of new a species.

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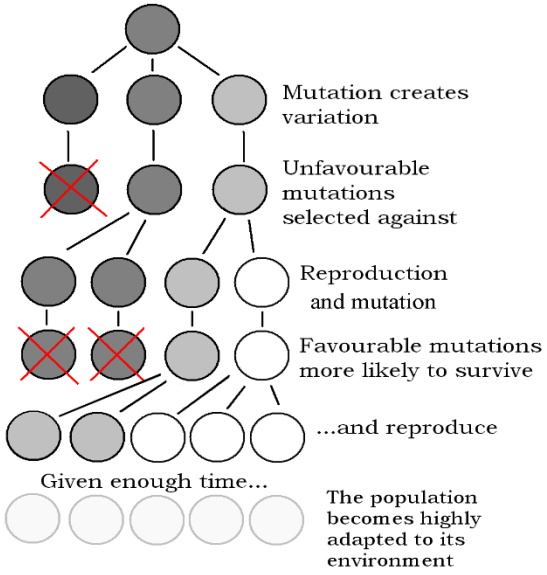
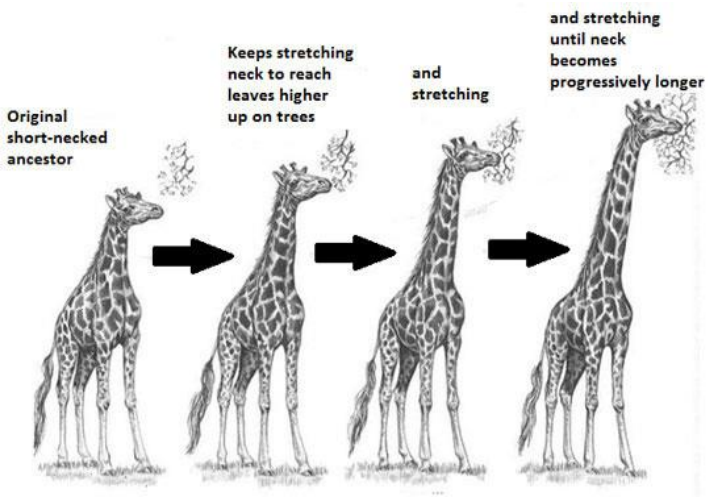
Several factors contribute to a change in the gene frequency of a population. For example, errors commonly occur during cell division, resulting in genes being changed in what are known as mutations. Although mutations, for the most part, are lethal for a species, they occasionally result in a gain of function which may help species adapt to their environment by being passed on to the subsequent generations. The figure on the right shows how unfavourable mutations are selected against, and how favourable mutations increase the chances of survival and reproduction.



2) What is the most likely cause of spontaneous mutations in species?

In n*atural selection*, a term coined by Charles Darwin, the fate of genetic variations depends on the environment. In other words, if certain traits or characteristics are better adapted to a particular environment, the species' chances of survival and ability to reproduce will be greater. As a result, their traits (genes) will be passed on to offspring and become more common in the future populations. A common example is the adaptation of a giraffe's neck which is believed to have stretched longer over generations to obtain food. Having the abundance of food increases the chances of survival and hence their ability to reproduce and pass their genes to future generations. This concept is commonly referred to as the "survival of the fittest."



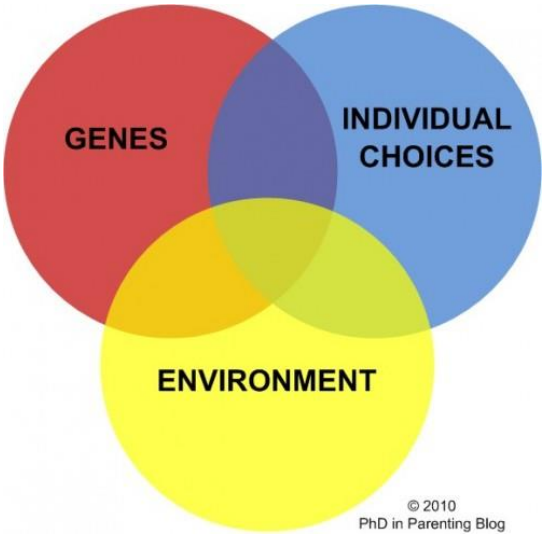
The effects of mutations and natural selection on evolution cannot explain all accounts of physical and behavioural traits that reflect the success of a gene. Darwin proposed another type of selection, sexual selection. Two types of sexual selection exist:

Intersexual selection - a member of one sex chooses a mate from the other sex, based on favourable characteristics such as attractiveness, height, youth, etc. For example, female peacocks choose male peacocks based on the attractive display of their feathers and the length of their tail because a "better" genetic makeup will be passed on to her offspring.

Intrasexual selection - members of the same sex compete for a partner of the opposite sex. For example males may become more muscular to compete with other males

3) Provide an example of intrasexual selection in the animal kingdom.

Environmental Influences on Genes and Heritability



The argument of whether nature (genes) or nurture (environment and life experiences) is responsible for human traits, characteristics and behaviour have been ongoing for decades and continues to this today. The similarities and differences of human beings CANNOT be merely simplified to genetics alone. Genes are not destiny; in other words, genes may be switched on or off based on the environment and the experiences of an idividual. Even highly heritable traits such as height can be modified by the environment. The only question that remains is: to what extent are genes and the environment influencing traits and behaviour? Studies commonly look at identical twins to try and answer some of these outstanding questions. Identical twins have the exact same genetic makeup and therefore any differences in traits or behaviour should theoretically be due to the environment. Interestingly, it is well known that even identical twins reared in the exact same environment have differences in traits and behavior.

4) If genes and the environment are exactly the same, what other factor is contributing to this difference in traits and behaviour?

To conclude, it is a combination of nature (genes) and nurture (environment and life choices) that makes each one of us unique, all the while displaying innate human characteristics such as language and cognition.

"In the real world there is no nature vs. nurture argument, only an infinitely complex and moment-by-moment interaction between genetic and environmental effects" - Gabor Mate

Answers:

1) Although we all have roughly the same genetic makeup, individuality results from a combination of factors including: inherited traits from the fusion of the egg and sperm that eventually form the body cells, genes communicating with one another to turn them on or off throughout the lifetime, environmental effects, and epigenetic effects
2) Excluding environmental exposures, the vast majority of mutations occur during cell division of the sperm and egg cells. Errors commonly occur during the copying of the original DNA sequence resulting in changes in DNA base sequences which are located on a gene.
3) Intrasexual selection in the animal kingdom often involves fighting. For example, male deer, lions, salmon, kangaroos and mustangs are all known to fight with males of the same species as a way to reproduce with available female(s).
4) The other factor is epigenetics which is a change in the expression of a gene (overexpression or under expression) without a change in the genetic code itself.