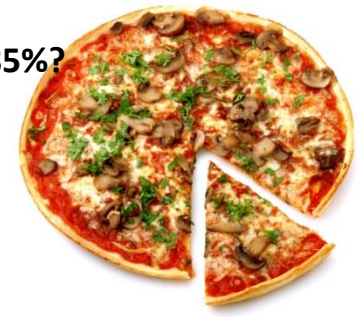
Activity - Gene-Environment Interactions

In the previous section, we investigated evolution in polygenic traits. Things get even more complicated when we consider that the environment itself can influence how genes affect a trait, causing even more continuous variation! So, how much of a trait is caused by genes and how much is caused by the environment?

This is a meaningless question! Finding an answer to this question is like trying to find out what percentage of a pizza is made using the ingredients, and what percentage is made using the recipe. It does not make sense! Importantly, this meaningless question is the basis of the historical "nature vs nurture" debate.

Ingredients: 85%?



Recipe: 15%?

This "debate" effectively asks the question: What characteristics of your identity are due to nature (your genes) and what characteristics are due to nurture (the environment)? For instance, questions are often asked about whether a disease is caused by genes inherited from your biological parents or from the environment (your physical, chemical, and biological exposures as well as your lifestyle factors). Upon first consideration, it may seem like these two independent components have isolated effects on particular diseases or traits.

However, if you think about this in more depth, most diseases and traits are each influenced by both genes *and* the environment. A number of diseases such as diabetes and cancer have *both* genetic and lifestyle links. Even infectious diseases are influenced by host-microorganism interactions because your immune system develops in relation to your genetics. We clearly need to think about this "debate" in a different way, as argued by Evelyn Fox Keller in The New Scientist:

http://www.nextnature.net/2010/10/goodbye-nature-vs-nurture/

A summary of the importance of finding gene-environment interactions can be found in a report by Traynor et al (2010). Have a read and think about the breadth of ways in which genes and the environment interact to make your body!

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2974322/

We will now investigate how the environment affects gene expression and how it can alter the phenotype of an organism. This is called *phenotypic plasticity.* Phenotypic plasticity of one form or another is found in all plants and animals. It may occur in form (morphology) or in any other phenotypic trait (behaviour, life history, metabolism, physiology etc.). Examples include the changes in bird plumage and mammal coat colour in summer compared to winter, the formation of castes in social insects, and changes in plant growth when exposed to either the shade or sun.

The following scientific paper by Moczek et al. (2011) summarises some good examples of phenotypic plasticity, and in particular, developmental plasticity. The paper is fairly advanced, but provides a lovely review of a very “hot topic” in evolutionary biology: how gene-environment interactions might promote evolutionary innovation. As you read through it, you should gain an understanding of just how complicated the relationship between genes, the environment, and the phenotype can be. This is certainly a little harder to comprehend than Mendelian genetics!

http://rspb.royalsocietypublishing.org/content/278/1719/2705.full.pdf+html