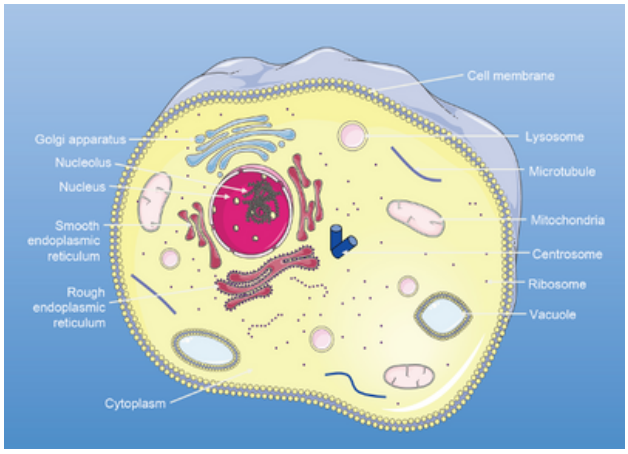
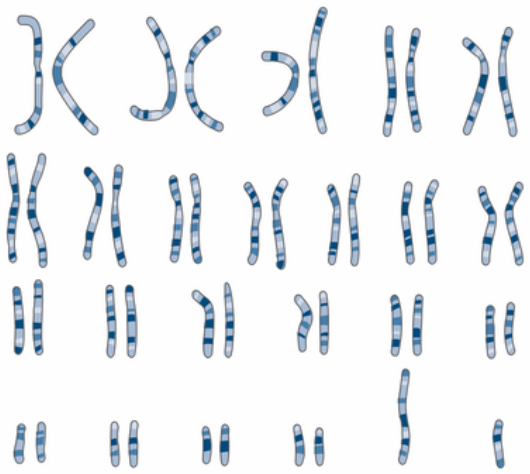
Genetics, Traits, and Taste
A BioME ME Bioscience Day Activity

Introduction to Cells and DNA

Every living thing is made up of building blocks called cells. In animals, our tissues and organs are each made of specialized cells that can carry out the functions needed in that particular tissue or organ. For example, bone cells are strong and rigid to form the structure in our skeletons, cells in the pancreas can make and secrete the hormone insulin, and skin cells provide a protective and waterproof barrier. Each of these cells has a slightly different shape (or, **morphology**), and the proteins it makes help it carry out its specialized jobs and functions. To make these **proteins** the cell will turn on certain genes that it needs. These genes are coded for our in **DNA, or deoxyribonucleic acid**, which is identical in each cell of our body and is stored in the nucleus at the center of the cell. The DNA is grouped in segments called **genes**, and the study of these genes and how they cause different traits in living organisms is called **genetics**. DNA is wound up into tight coils called **chromosomes**, inside our nucleus. Humans have 46 chromosomes: one set of 23 chromosomes from our mother and one set of 23 chromosomes from our father. 22 of these chromosomes are in pairs, plus we inherit a sex chromosome (X or Y) from each parent. Therefore, we have two copies of each gene from the paired chromosomes, or two variations called **alleles**. Often, only one of these alleles will be expressed, giving us a **genetic trait**.



A prototypical animal cell (from Servier Medical Art):



*A set of Chromosomes, visualized in a **karyotype** (from Servier Medical Art). Note there are two copies of each chromosome*

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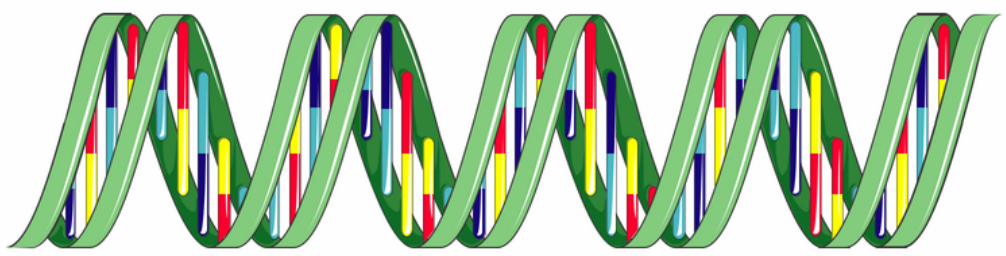
Gene Expression

For each organism, the DNA in the nucleus of our cells is slightly different. Dogs need to make tails and have a good sense of smell, worms need moist skin and to wriggle on the ground, and butterflies need wings and colorful patterns. Their DNA helps give them these important and individual traits. Even within one organism, such as dogs, the DNA can be different and lead to many different types of dogs with big ears short legs, long fur, or strong jaws. The same is true for humans. Each of us is special and unique in part because of our individual DNA, and partly because of our environment as we grow up.

DNA is shaped like a twisted ladder, or double-helix, and is comprised of 4 nitrogenous bases called Adenine (A), Thymine (T), Cytosine (C) and Guanine (G). The repeating pattern of these nucleic acids acts like a code, which cellular machinery can decipher into amino acids – or the building blocks of proteins. This process of decoding DNA into proteins is called **gene expression**. Basically, our cells read the letters in the DNA and determine which protein needs to be made for that cell to function properly.

DNA structure: the green backbone is made of sugar (deoxyribose) and phosphates. The colored bars indicate the 4 nitrogen-containing "base pairs". A pairs with T and C pairs with G as the rungs of the ladder.



Sometimes, DNA has mutations, which can lead to problems in gene expression and may cause health problems. Other times, these mutations can lead to a beneficial trait in the offspring, which may be carried on through many generations of reproduction.

Comparing Inherited Human Traits
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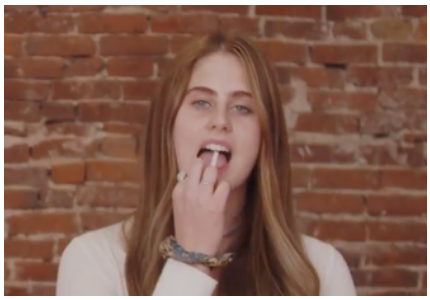
Trait Profile - PTC Tasting



Does not taste PTC

Tastes PTC

For some people the chemical phenylthiocarbamide (PTC) tastes very bitter. For others, it is tasteless.

The ability to taste PTC shows dominant inheritance and is controlled by a gene on chromosomes 7. This gene codes for part of the bitter taste receptor in tongue cells. One of its five alleles (forms) causes a lack of ability to sense bitter tastes; the other four alleles produce intermediate to fully sensitive taste abilities. Approximately 75% of people can taste PTC while the remaining 25% cannot.

PTC-like chemicals are found in the Brassica family of vegetables, such as cabbage, brussel sprouts, and broccoli. People who can taste PTC often do not enjoy eating these vegetables, since they taste bitter to them. Non-tasters tend not to notice bitter tastes and therefore may be more likely to become addicted to nicotine (which is bitter).

PTC-tasting ability has also provided information related to human evolution. Populations in Sub-Sahara Africa, and people who are descended from this area, contain at least five forms of the gene. Some of these forms confer a PTC-tasting ability that is intermediate between taster and non-taster. However, with only a few exceptions, only two forms – taster and non- taster – are found in populations outside of Africa and their descendents. This is consistent with the out-of-Africa hypothesis of modern human origins.

Some scientists think that tasters have fewer cavities, suggesting that there might be a substance in the saliva of tasters that inhibits the bacteria that cause cavities to form. Others think that PTC tasting may be in some way connected with thyroid function.

PTC tasting was a chance discovery in 1931.

Source: http://gslc.genetics.utah.edu/

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Additional Resources

Additional Genetics Resources

National Library of Medicine genetics websites:
https://nnlm.gov/sites/default/files/mar/files/Exploring%20Genetics%20Kit.pdf
DNA Day Activities (NIH): *https://www.genome.gov/dna-day/get-activity-ideas*

Genetic Traits Inventory Activities

https://learn.genetics.utah.edu/content/basics/activities/pdfs/InventoryOfTraits.pdf
https://www.koshland-science-museum.org/sites/default/files/uploaded-files/Inventory_of_Your_Traits.pdf
http://www2.mbusd.org/staff/pware/labs/HumanTraits.pdf

Further Reading re PTC and Taste Traits

Genetics and PTC: *https://learn.genetics.utah.edu/content/basics/ptc/*
Genetics of taste (full activity):
https://gsoutreach.gs.washington.edu/files/genetics_of_taste.pdf