Lesson 3: Wednesday, March 25, 2020. Biology MHS

AIM: How do proteins control traits? And how do we control which proteins we are making?

- You said that genes code for proteins. What the heck- I thought that genes controlled my eye color, hair texture, skin color, height, and stuff like that. How do "proteins" give me **traits**??
- ALSO, if my DNA codes for "who I am," and DNA codes for proteins, wouldn't that mean that I'm 100% protein?...
- Great questions. Let's look at some examples of proteins of the body.

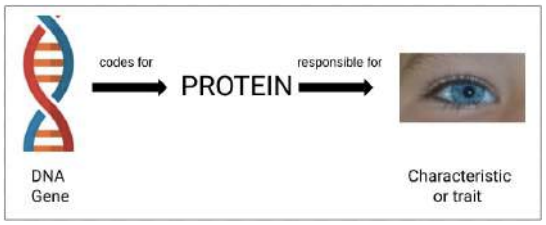
Protein	Function
Melanin	A **pigment** protein that controls skin, eye, and hair color. Also controls freckles
Hemoglobin	A protein found in red blood cells that transports oxygen
Elastin and collagen	Structural proteins that control skin texture and gives skin elasticity.
Insulin	A protein hormone that helps to regular blood glucose levels
Myosin	A protein that builds muscle tissue
Keratin	A protein found in hair
Antibodies	Special proteins made by white blood cells that help to flag pathogens
Receptor molecules	Special proteins found on the surface of cells to receive chemical messages
Hormones	Many hormones are protein molecule. Each has a specific shape which sends a specific chemical message

Wow! That's a lot of protein. So, what about all of the parts of my body that are not protein?...

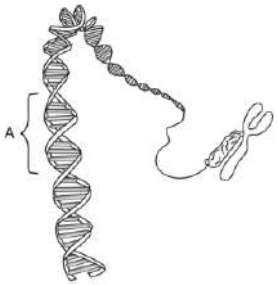
Genes code for **ENZYMES**. All enzymes are **proteins**. Enzymes catalyze all of the *other* chemical reactions needed to build all of the *other* important molecules that your body needs!! (Cool, right?).

Let's look more at how genes work.

- A single gene can control *many traits.*
- A single trait is often controlled *by many different genes.*
    - This is why there isn't just ONE shade of brown hair or ONE shade of blue eyes- there are many different genes that control these traits!



Gene Expression:

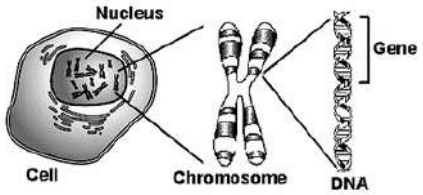
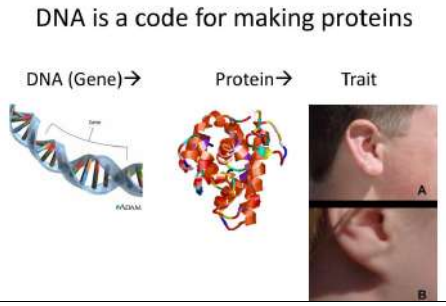
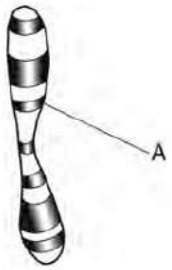


- **If a gene is being expressed, it is actively being use to code for a protein!**
- Genes can be "*turned off*," and traits will not be expressed.
- Gene expression can be "*turned up*" or "*turned down*."
- If gene expression is **turned up**, you are making *more* proteins. If gene expression is **turned down**, you are making *less* protein. If gene expression is turned off, you are *not* coding for any proteins.
- Gene expression can change throughout an organisms' lifetime. Gene expression can be *affected by the environment.*

Example:

Pigments are ***proteins*** that control **color** in an organism. **Melanin** is a skin pigment. People with *high expression* of the *melanin gene* produce a lot of pigments and have *darker* skin. People with *lower gene expression* of the melanin gene make less pigment proteins and have lighter skin. Expression of the melanin gene is *affected by sunlight.* When people are exposed to radiation from the sun, the expression of the melanin gene *increases*, and the skin gets darker. This is what a suntan is! Expression of skin color genes is affected by the environment.

Here are A LOT of examples. The more you read, the better you will understand the idea of gene expression.

		
Don't' forget: *A gene is a segment of DNA.* Genes are represented as "*bands*" on a chromosome.	Sounds weird, but DNA codes for proteins! Proteins determine your traits!!	"***A***" represents a GENE. This gene has the instructions to produce a specific PROTEIN. The expression of this gene can be influenced by the ENVIRONMENT.

Hair Color and Age: Hair color is controlled by the *expression of genes* that control **pigments**. What is a sign of aging? *Loss* of hair pigment. This takes place when *gene expression is turned off.* When the cells no longer produce proteins that control color, the hair *turns white.* The expression of these genes is affected by age.

Plant Leaves in the Fall: Plant leaves contain several genes that control leaf color. Each gene is made from a specific sequence of bases, and each gene *codes for a different protein*. Some proteins produce green color, orange color, yellow color, or red color. During the fall, ***the traits of the trees change***. Green leaves begin to turn yellow, red, or orange. This change is triggered by a ***change in temperature.*** Once it gets colder, plants *stop expressing* the green gene, and *begin expressing genes* that produce other colors like red and yellow.

Hydrangeas and Soil pH: A hydrangea is a bush plant that produces flowers. These flowers can be pink or blue. The *expression of genes* that control flower color is affected by *the pH of the soil*! If the soil is slightly acidic, the flowers *express the blue genes*. If the hydrangea is in an environment with slightly *basic* soil, the flowers will *express genes* that produce pink color. Gene expression can be affected by pH level!

Lactose Intolerance: Lactose intolerance is a condition where someone does not produce *enough* of an enzyme called **lactase**. Lactase helps to break down the *lactose* found in dairy products. If you don't produce *enough* lactase enzyme, you have trouble digesting dairy. This occurs when there is ***low expression*** of the gene that controls lactase production. Don't forget- all enzymes are proteins, and all enzymes are coded for by your DNA!

The Artic Fox and Seasons: Some organisms *lose their fur color* during this winter months. An example is the Artic fox. In the summer, the fox *expresses genes* that produce a reddish-brown color. During the winter months, the gene expression is **turned off**, and the fox stops producing color proteins. This causes the fox fur to turn WHITE (*the absence of color*). White fur in the winter months is an advantage because it helps the fox to blend into its environment. *Gene expression is affected by the environment!*

Cells in your Body. Don't forget, all cells in your body came from the **zygote**. All cells in your body are **genetically identical**. If brain cells and muscle cells are genetically identical, then how can they look and act so different? *Different cells express different genes.* This means that different cells *code for different proteins*, which allows cells to do different jobs. This includes different enzymes that can catalyze different reactions, different receptors to receive different messages, and different hormones to send different messages. *Differential gene expression* is how cells **differentiate** from one another during growth and development!

Gene Expression and Cancer: In some cancerous cells, **gene expression** becomes ***unregulated***. The expression of genes that *start* cell division can *increase*, and this can cause cells to *divide uncontrollably.* Likewise, the expression of genes that *prevent* cell division can be *shut off*, also leading to uncontrollable cell division. BCRA1 and BRCA2 are known genes that are linked to breast cancer. Genetic tests can tell you if you are at risk for certain types of cancer.

FINAL CONCLUSION: *Genes code for proteins. Proteins control traits. Gene expression describes whether or not a cell is using a gene to make a protein. Gene expression can be influenced by the environment.*