|  |
| --- |
| **Genomics: The Past, Present and Future**  In the past year, much has been said about genomics. In all, it's been a lot of information to take in so here's a brief recap of what genomics is and how it came about.  **Back to the Basics** Each cell within a cow contains 30 chromosomes. The chromosomes contain strands of DNA. The DNA consists of different pairs of nucleotides (the letters A,T,C, and G). The order or sequence of those 3 billion nucleotides contains all the instructions for creating the cow’s body. Some animals are better than others because of slight changes in the sequences of the letters in their DNA.  Cell-Chromo-DNA-High.jpg  Genomic selection is the process of combining information from both traditional ways of evaluating animals (such as judging them and scoring their offspring) with genetic markers.  Genetic markers are also known as SNPs (pronounced ‘*snips’*). SNPs are the variations in a DNA sequence that occur when a single nucleotide (A,T,C, or G) is altered. This single change may be enough to help scientists determine if an animal carries a specific gene for a specific trait. Presence or absence of an SNP can tell scientists whether or not the trait associated with that SNP is present or absent.  In the past, agriculturalists would have to wait many years after a bull was born to determine how valuable it was. A company that owned a bull would have to wait the daughters of a bull had their own daughters and started producing milk before they could determine the value of the bull. Specialists would have to drive out to the farms that had daughters from this particular bull, visibly evaluate those daughters, and record all of this information into a large database. The averages of the recorded information would help the company to determine whether or not their bull was genetically valuable.  Today, geneticists can simply use the information gathered from the genetic markers found in the animal’s DNA to determine the value of that bull. How is the information from the genetic markers gathered? First, samples of blood, hair or semen are collected. DNA is then extracted from these samples. The DNA is then placed on a chip (sort of like a computer chip). This chip can examine over 50,000 SNPs throughout the bovine chromosomes.  The United States Department of Agriculture (USDA) conducted research and determined that about 38,000 of those 50,000 SNPs found in bovine DNA are helpful for determining the genetic value of a bull. The USDA did this by analyzing the DNA from thousands of bulls from the past 40 years. The USDA researchers found connections between certain SNPs and certain genetic traits. By finding that specific SNPs are usually only found when certain valuable traits are present in an animal, USDA researchers could develop genetic tests that would determine whether or not a bull had high levels of desirable traits based on the 38,000 SNPs that have been identified.  The impact of this knowledge is HUGE! In a nutshell, we can know the genetic potential of a baby calf as soon as it is born (and sometimes even sooner!). Dr. Kent Weigel of the University of Wisconsin-Madison explained the value of genomics by stating, "We can combine the animal's parent average with genomic information to get a ‘genomic PTA' with a reliability of 60 to 70 percent. This is vastly better than the reliability of merely its parent average which is typically only 30 to 40 percent."  In other words, by combining the information of the parent’s physical traits with the scanned genes of the calf, we can tell with 70% accuracy how valuable that animal will be the moment it is born. Prior to this, the best accuracy agriculturalists had was 40%, meaning that genomics has nearly doubled the predictive power of genetics.  **What Does the Future Hold?** The current method of using 50,000 genetic markers (SNPs) to evaluate bulls for their genetic value has had a significant impact on animal agriculture. It has enabled breeders to determine the value of an animal the moment we can get a DNA sample. Instead of waiting years and years to know whether or not an animal can perform, we can know the moment it is born.  It is very likely that the science of animal genomics will continue to advance and become more widespread and common as the cost of SNP chips decreases. It is likely that in the near future SNP chips will be used not only by scientists in laboratories, but also by farmers in their own business and on their own animals.  This means that the average farmer could know whether or not he or she has a top-performing animal the moment it is born. A farmer could tell what problems an animal could have later in its life, possibly allowing for the prevention of that problem. Management and feeding could be tailored to an animal’s specific needs, maximizing their growth and development.  This scenario has already become more possible with the creation of a ‘mini’ SNP chip with 3000 genetic markers. The mini chip could have several potential applications. A dairy producer will have the ability to determine the optimum type of semen to use on that heifer. For example, if a farmer has to breed 20 heifers, he could select the best 5 to breed with the best semen he has on the farm. This could help a farmer improve their herd genetics more rapidly and prevent the possibility of wasting good genetics on poor animals.  Never will genetic testing be smarter than Mother Nature, or replace good common-sense decision making. However, future genomic technologies that are cost efficient will give farmers the powerful tools to improve their practices. The potential of genomics is enormous, and we are just beginning to make use of that potential. |

*This reading was taken from Genomics: The Past, Present and Future (2006), written by Genex Cooperative, Inc. The article was modified for classroom use by C. Kohn, Waterford Union High School. The* [*original article can be found by clicking here*](http://genex.crinet.com/page3246/GenomicsThePastPresentAndFuture)*.*

Genomics: The Past, Present, & Future  
Genex Cooperative Inc., <http://genex.crinet.com/page3246/GenomicsThePastPresentAndFuture>

Name: Hour Date:

Date Assignment is due: *end of the hour* Why late? Score   
 Day of Week Date If your project was late, describe why**Directions** – using the accompanying reading, please complete the questions below. You may work together quietly, but you are responsible for completing your own answers.

1. Each cell in a cow contains how many chromosomes? What are the chromosomes made of?
2. What is a nucleotide?
3. Define DNA Sequence:
4. How does DNA relate to why some animals are better than others?
5. What is Genomic Selection?
6. What is a Genetic Marker?
7. Before genomics, how did geneticists determine the genetic value of a bull?
8. How many genetic markers (SNPs) have been identified in cows by the USDA?
9. How did USDA researchers develop genetic tests for specific traits using SNPs? (in other words, how did they figure out which SNPs are for which traits?)
10. How accurate are predictions about an animal’s value when using genomics?
11. How accurate are predictions about an animal’s value when using traditional methods?
12. Complete this sentence: By combining the information of   
      
    with the , we can tell with 70% accuracy

1. With traditional methods, how long did producers have to wait in order to find out the performance value of their animals?
2. How soon could a producer find out the performance value of animals using genomics?
3. How will farmers be affected by SNP chips in the near future? Describe three ways in which farming could be improved by the use of SNP chips on the farm:  
     
   1   
     
   2   
     
   3
4. How could the recently-developed mini SNP chip help a farmer make more money?
5. (2 pts) In the space below, summarize how a geneticist would determine the value of an animal the day it is born. Be sure to include the following: SNPs, traditional methods, accuracy