Optional Homework Instructions: Print and read this article. Answer the questions at the end to the best of your ability. Extra credit will be given based on quality of responses.
Genetics and Gene Therapy

Genetics

Genetics refers to the study of heredity, which is the process in which a parent passes certain traits (via genes) to their offspring. These inherited genes will become traits will be seen in characteristics such as hair color, height, intelligence, etc. However, some genes carry diseases and disorders that could also be passed to the offspring. Such genetic diseases can include some cancers as well as mental and physical disorders (Keller, 2015).

DNA, Genes and Heredity

Your DNA is your body's blueprint and just like a blueprint of a building, your genes carry all the information to make you what you are. Inside each cell, your DNA is split into 46 chromosomes that are coiled into very dense packets. Within these chromosomes are short coding segments called genes that describe how specific traits will be displayed as you age.

Your DNA is a massive, double helix structure. If you were to stretch each chromosome out and attach them end-to-end, the DNA in each of your cells would measure 2 m long. If you attached the DNA from each of your cells into a long strand, it would measure to the Moon and back 3000 times!

The human body consists of tens of thousands of genes each of which is found inside your DNA. Your DNA consists of four chemical compounds (or bases); adenine, thymine, guanine and cytosine. Since you have two parents at conception, each parent provides a single copy of each gene, essentially giving you a duplicate blueprint with slight modifications. The DNA, which holds the genes, is broken down into forty-six chromosomes. (Mandal, 2009).

A genome is an organism's complete set of genetic information and consists of about 3.2 billion chemical base pairs (Duke, 2013) and is found in every cell. That's enough information to fill 200, 1,000-page phonebooks! Although genes are the body's blueprints, on the cellular level, their job is to simply produce proteins that conduct various processes throughout the body. These proteins may carry oxygen through the blood like hemoglobin or produce collagen that acts like glue, keeping you together. Others are responsible for the production of enzymes that aid cellular processes like digestion and other chemical reactions. Also, a gene known as a tumor suppressor produces proteins that regulate cell division. If this gene fails to function properly, uncontrolled cell division will occur which could lead to cancer.
Genetic Disorders

When a cell divides, the DNA first needs to be replicated. In some cases, an error in the replication process may occur leading to a mutation or change in the genetic material. DNA is composed of many non-coding sequences along with ones that code for proteins, a.k.a., genes. Therefore, a change in the genetic code may alter a certain gene sequence and lead to what's called a mutation. Mutations can also arise if a cell's DNA is exposed to radiation or chemical toxins. There are a variety of mutations that may either not affect the organism (silent mutation) or affect it to some degree (missense and nonsense mutations). Some mutations are advantageous and allow the organism to survive and have offspring. The theory of evolution is built around the idea of survival of the fittest where organisms best suited to survive, do. Many of these evolutionary advantages arise from mutations. Mutations can also be very harmful and result in an abnormal and/or a non-functioning protein. Depending on the function and importance of this protein, negative mutations can be fatal. In all types of mutations, only germ line (sperm and egg producing cells) will be passed on to an offspring.

Mutations are quite common. According to a study, every human being is born with five to thirty significant germ line mutations in their DNA. However, since we receive two copies of each gene (one from mom and one from dad), the good copy often overrides the bad and the person is unaware of the mutation. An example of this is the blood-clotting disease, hemophilia. Unfortunately other disorders such as Huntington’s chorea, only require only one faulty gene for the disease to be expressed (Houwink, E., Luijk, S., Henneman, L., Van der Vleuten, C., Jan Dinant, G., & Cornel, M., 2011). Common diseases, such as cancers, diabetes, and hypertension cannot be explained as simply as above. These types of disorders develop as the result of the combined interactions of genes and environmental stimuli that include various chemical toxins, diet, and lifestyle, (National Human Genome Research Institute, 2015).

Gene Therapy

Gene therapy is the treatment of various ailments at the genetic level and is used to treat diseases that result from faulty genes. An example of this is the treatment for Type 1 diabetes, which is characterized by an inability to produce insulin due to a non-functional gene in the pancreas. First, the functional gene is inserted into a different organism such as a bacterium, which is allowed to duplicate many times over producing numerous copies of the working gene. Next, some cells from the faulty pancreas are removed from the patient. Lastly, the functional gene is extracted from the bacteria and inserted into the DNA of the infected person. Once this person's cells have had some time to divide, they will be able to produce their own insulin protein.
Future Application

Scientists have just scratched the surface when it comes to their genetic understanding and many questions are still left unanswered. Additional research and information is needed to better understand the intricate roles genes play in the creation of various diseases as well as how various genes interact with each other inside living things. Our knowledge of the genome is growing along with our technology. In 2007, the first human genome was completely sequenced at a cost of one million dollars! Today, entire genomes can be sequenced for less than $200 and that number is quickly decreasing. However, the problem now lies in our ability to analyse the deciphered genetic code quickly and efficiently. The reason that this is an issue is the massive computing power that is needed to analyse the over three billions nucleotides. Currently, it costs around $15,000 to have this done which decreases its availability to the public. Thankfully though, this number, like its counterpart the sequencing, is becoming less and less each year. One day perhaps, you will wear a device that continually analyses your genetic health and sends that information to your smartphone app as well as your doctor.

The power of genetic research is in its ability to identify the body’s specific genetic need and treat it. Knowing what’s wrong with a person at the genetic level can lead to ultra-targeted, person-specific treatments, this is known as personalized medicine. Furthermore, genetic therapies can infiltrate the person’s DNA and correct faulty genes on the spot either reversing an illness or preventing it from ever manifesting in the first place. In 20 years, Earth’s inhabitants might be free from all genetic diseases.

Genetic screening is a means of testing one’s DNA to look for genes that may predispose someone or their children to various diseases. Knowing what to expect will allow people to take a proactive role by changing their diet and lifestyle or by undergoing particular procedures or drug treatments. Others who are carriers of diseases such as Huntington’s may choose not to have children so that the disease isn’t passed on to the next generation. Since Huntington’s doesn’t show until someone is in adulthood, genetic screening would inform someone of their genetic makeup prior to having children. Genetic screening and manipulation could also one day allow parents to choose their child’s characteristics. Want your child to be 5’9” with blue eyes and a strong build? No problem. Want brown eyes instead? Easy, all it takes is a click of a button. Although the idea of these “designer babies” as they are called, is a bit scary, genetic manipulation will someday allow for this possibility.
Reading Comprehension Questions:

1. In your own words, describe what genetics is.
2. How is your DNA like your body’s blueprint?
3. Describe how a person’s genome, DNA, genes and chromosomes are related to each other.
4. What is the primary function of genes?
5. Why could a mutation not affect an organism at all?
6. Explain why someone with hemophilia requires two bad genes while Huntington’s does not?
7. In your opinion, how does inbreeding (having children with those closely related to you), increase your offspring’s chance of having a genetic disease?
8. What is gene therapy?
9. What do you think of the statement: “One day perhaps, you will wear a device that continually analyses your genetic health and sends that information to your smartphone app as well as your doctor”? Would this be a good thing in your opinion? Why or why not?
10. What other ways do you think your genetic information could be screened regularly?
11. Why is targeted medicine better than general (one size fits all) medicine?
12. What is your opinion on the whole “designer baby” idea? Would your answer change if instead of choosing eye color, this process prevented your child from having a genetic disorder such as Down Syndrome?
1. In your own words, describe what genetics is.

2. How is your DNA like your body's blueprint? **Your genes carry all the information to make you what you are.**

3. Describe how a person's genome, DNA, genes and chromosomes are related to each other. **The genome and DNA carry the genetic information on 46 separate chromosomes each of which carries hundreds of genes.**

4. What is the primary function of genes? **To create proteins.**

5. Why could a mutation not affect an organism at all? **The mutation could be in a non-coding region or it may not change the protein produced.**

6. Explain why someone with hemophilia requires two bad genes while Huntington's does not? **The good hemophilia gene can override the bad one, while in Huntington's, this doesn't happen.**

7. In your opinion, how does inbreeding (having children with those closely related to you), increase your offspring's chance of having a genetic disease? **As described, people are born with numerous faulty genes however; from person to person who are unrelated, it is unlikely that the same mutation will be found. In most people therefore, the faulty gene is simply overridden by the correct counterpart and the disease does not manifest. However, since you share much of your DNA with close relatives, there is an increased chance that they will have the same genetic mutation. If they have a child, there is a greater chance that the offspring will have two copies of the faulty gene and the disease will be expressed.**

8. What is gene therapy? **Gene therapy is the treatment of various ailments at the genetic level.**

9. What do you think of the statement: “One day perhaps, you will wear a device that continually analyses your genetic health and sends that information to your smartphone app as well as your doctor”? Would this be a good thing in your opinion? Why or why not?

10. What other ways do you think your genetic information could be screened regularly?

11. Why is targeted medicine better than general (one size fits all) medicine? **It can identify and address the body's specific needs, as illnesses are different depending on the person.**

12. What is your opinion on the whole “designer baby” idea? Would your answer change if instead of choosing eye color, this process prevented your child from having a genetic disorder such as Down Syndrome?

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**References**


