**Identical Twins, Identical Fates? An Introduction to Epigenetics**

**Part I – Coming Home**

Elise was excited as she boarded the bus. She had just finished her first year at college and was looking forward to her first night back home since winter break, which would include mom’s spaghetti and meatballs and catching up with her family. She couldn’t wait to curl up on the couch with her cat Ziggy snuggled next to her, and she was hopeful that her sister, Shannon, would be willing to join her there, since they had talked very little since Elise’s last visit home.

As she settled in for the four-hour bus ride home, Elise pulled out her iPhone, put on some music, and started looking through old photographs. She came across a few of her and her sister taken at Christmas—the last time they had seen each other. Looking at Shannon was like looking in the mirror. After all, they were identical twins. Elise recalled all of the pranks that she and Shannon used to pull in school when they were kids. In 5th grade, they once made it all the way to lunchtime before their teachers realized that they had swapped classes and were impersonating one another!

Shannon and Elise used to have so much fun together, but things had changed. Elise was worried about her sister and the serious health troubles she had been having over the past year and a half. And she couldn’t help but wonder to herself, “Are the same troubles heading my way?”

***Questions***

1. What exactly are twins, and how do they arise? Your response should distinguish between the two different types of twins.

2. Do you think identical twins completely identical? Why or why not?

3. What can studying twins tell us about the *genetic influence* on a particular trait?

**Part II – The Diagnosis**

Elise stared out the window of the bus at the rush-hour traffic that had befallen travelers on the other side of the highway. She recalled that night back in November when her mother called her at school to share the fateful news about her sister. “Shannon has been diagnosed with schizophrenia,” was what she had said. The words had dropped into the pit of Elise’s stomach.

She had known that something was going wrong with her sister. The summer before she left for college, Elise noticed changes in Shannon’s behavior. Despite being an avid swimmer and lifeguard, Shannon quit her highly coveted swim camp instructor position just two weeks into the summer. She seemed withdrawn and unmotivated, and had also unexpectedly decided not to attend college in the fall, despite Elise’s and her parent’s efforts to convince her otherwise.

But Elise did not get to see the worst of Shannon’s behavior, when she began having hallucinations and couldn’t seem to carry on a coherent conversation with her parents.

Elise had done some research about schizophrenia after hearing of her sister’s diagnosis. She did not like what she found out. Apparently, schizophrenia has a tendency to run in families. In fact, studies indicate that a sibling of a schizophrenic has a 10-fold higher risk of developing schizophrenia over the general population. Elise began to worry about her own mental health. She decided she would do some further investigation into the disease once she got home for summer break.

***Questions***

1. What causes genetic variation? For example, what causes some people to have curly hair and others to not? What causes some people to have a genetic disease such as cystic fi brosis and others to not?

2. What does it mean when a trait or a disease “runs in families”?

3. What could be some possible *genetic* and *non-genetic* causes of Shannon’s schizophrenia?

**Part III – Just How “Identical” Are We?**

Elise had been home from college for a week, and she was still preoccupied with Shannon’s diagnosis and her own potential risk for mental illness. Elise expressed her anxiety and concerns to her mother one night after dinner. “Elise,” her mother said, “your concerns are perfectly valid, and you have every reason to want to get more information. Why don’t we make you an appointment to consult with a psychiatrist?” Elise decided to make the appointment the next day.

Elise left Dr. O’Brien’s office feeling that some of the weight had been lifted from her shoulders. On the car ride home, she thought about the things that Dr. O’Brien had said to her during their consultation. “It was good of you to come in to see me, Elise. You are absolutely right to have concerns for yourself when your identical twin has been diagnosed with schizophrenia. Research shows that schizophrenia is almost 50% heritable, and since you share nearly identical DNA with your sister, that puts you at a higher risk for developing this disease as well.” “Fifty percent may sound like a scary number, but remember that schizophrenia is a very complex disease, and 50% of what causes schizophrenia is due to things *other* than your DNA.” “Well, like what? What else could be contributing to Shannon’s schizophrenia that wouldn’t necessarily affect me?” Elise asked. Dr. O’Brien replied, “There are many, many environmental influences that seem to play a role in the development of this disease, such as increased stresses and anxiety, or difficult relationships with other people. Interestingly, there is some groundbreaking research that is going on that suggests that the *environment* itself might even play a role at influencing one’s DNA at the *molecular level*. This concept is called *epigenetics*. An example of epigenetics in nature is the calico cat. Each calico cat has a unique orange and black fur color pattern because of alterations, called epigenetic

changes, which occur within the cells that produce coat color during the cat’s development. Research in the field of epigenetics suggests that individuals with schizophrenia appear to have some of these epigenetic changes to their DNA that are due to environmental influences, and that these alterations could be contributing to their development of mental illness.” “But wouldn’t I also have these ‘epigenetic alterations’ in my DNA?” Elise asked. “Not necessarily, because you and Shannon have not experienced completely identical environments throughout your lives. For example, you and Shannon have had different teachers and jobs throughout high school. And I also understand that you spent many childhood summers with a friend and her family out in the Grand Canyon, while your sister was off at swim camps. If you are interested, I can give you some literature to read about this subject.” Elise was definitely interested. She took the articles and headed home.

***Questions***

1. Speculate on some ways that the environment might have an influence on a person’s genes.

**Part IV – What Really is “Epigenetics”?**

Despite being three weeks into her summer break, Elise felt like she was back in school. The more she read about the topic of epigenetics, the more fascinated she became, and she found herself spending most of her days on the Internet doing research. Elise had learned about genetics in her general biology class and thought she had a pretty good idea of how the Laws of Mendel worked, but this whole field of epigenetics seemed to take the idea of inheritance to another level. She was particularly fascinated by an article that Dr. O’Brien had given her regarding epigenetic differences between identical twins. The article suggested that during one’s lifetime epigenetic changes occur to one’s DNA that can affect gene expression, and therefore whether or not one will express a certain trait. These epigenetic changes are influenced by one’s environment and behaviors, so despite having identical DNA, identical twins will not always have the same epigenetic changes, and therefore, will not always express the same traits.

Epigenetic differences arise during the lifetime of identical twins. Overtime Elise and Shannon would become more and more epigenetically dissimilar, even though they did carry the same genes. Perhaps she would not share the same fate as her sister after all.

***Questions***

1. Do you think Elise needs to be worried about her own mental health? Why or why not? If you were a health-care professional, what would you advise Elise to do?