Little Girl Lost: A Case Study on Defective Cellular Organelles by Tracie Y. Hudson

Part I – Bringing Home Baby

After many years of trying to get pregnant again, Kenneth and Vicki Johnson were thrilled at the birth of their baby Sally. Their first child had died mysteriously at 12 months of age, and it had taken five years for Vicki to become pregnant again. Both the pregnancy and delivery had gone smoothly. But in the back of their minds, Kenneth and Vicki couldn't help but worry about their baby girl who had died five years before. For the first three months, baby Sally seemed fine. She was meeting all of her developmental milestones. However, at four months old she developed a severe viral respiratory infection. While her body tried to fight the infection, Sally began to have problems sucking and turning her head. She wasn't gaining weight as she should. She appeared to have little appetite, and she began vomiting. She was irritable and cried almost continuously. These symptoms are not characteristic of a respiratory infection. Vicki and Kenneth were afraid because these symptoms seemed very similar to what had happened prior to the death of their first child.

Reflection Questions	
1. What triggered Sally's symptoms and her parents' concern?	
2. List Sally's symptoms at home.	

"What is going on? I can't believe this is happening again," Kenneth thought to himself. Kenneth and Vicki rushed Sally to the emergency room. While they waited in the emergency room, Sally had a seizure. As the doctors tried to stabilize her, they noticed that Sally had decreased muscle tone. The ER doctor ordered metabolic screening of Sally's blood and urine, and an MRI (magnetic resonance imaging). While waiting for the results of the screen and the MRI, Kenneth told the doctor that five years ago their first child died mysteriously at 12 months of age after suffering from similar symptoms. A short time later, the results of the blood and urine tests came back. The preliminary tests on Sally showed she had elevated plasma lactate and pyruvate levels. The MRI showed discrete bilaterally symmetric lesions in the basal ganglia and brain stem. The failure to thrive, regression of developmental skills during a viral infection, vomiting, and seizure suggested that multiple organ systems were being affected.

3. What symptoms caused her parents to take her to the doctor? What symptoms presented while at the hospital?

Reflection Questions	
1. What prompted Sally's parents' to take her to the hospital?	
2. List Sally's symptoms at the hospital.	

Part II – The Diagnosis

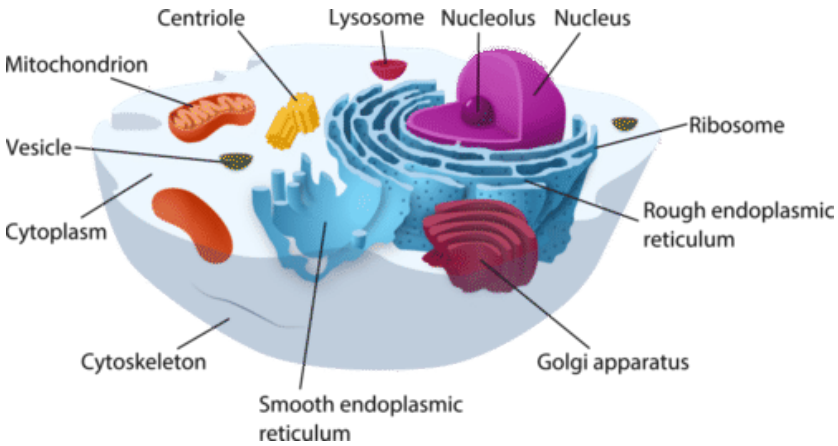
"Given the results of the metabolic screen, the multiple organ system involvement, and the telltale lesions in the brain, it appears that Sally has Leigh Syndrome (LS)," reported the ER doctor. "Leigh syndrome is a severe neurological disorder that usually arises in the first year of life. It is characterized by the degeneration of the central nervous system. Its onset is typically triggered by a viral illness. This condition is characterized by progressive loss of mental and movement abilities and typically results in death within a couple of years, usually due to respiratory failure," explained the doctor.

Reflection Questions	
1. What did the doctor's conclude was Sally's diagnosis?	
2. What are the characteristics of this condition?	

Part III– Understanding the Cell

Kenneth and Vicki were in a state of shock as they drove home. The doctor had said that Sally's disease was caused by a defective cellular organelle. However he hadn't explained what an organelle was or which one was defective. Kenneth decided to do some research. "I need to better understand the source of Sally's illness," Kenneth said with resolve. He searched the Internet for information using the words "cellular organelle." He found the following picture and information.

Features of Plant and Animal Cells: All living organisms are made of one or more cells. Cells contain organelles. **Organelles** are defined as a specialized subunit within a cell that has a specific function. The information below describes the various organelles found in cells along with their functions. Cells have a nucleus. The **nucleus** controls the cell's activities. Also contained within the nucleus is the nucleolus. The **nucleolus** is used in the production of ribosomes. The nucleus also contains the chromatin. **Chromatin** is uncondensed DNA and serves as the blueprint for controlling the cell's functions and for building more cells. Outside the nucleus is the **cytoplasm**. This aqueous material contains numerous other organelles**. Ribosomes** are found floating in the cytoplasm or attached to the **endoplasmic reticulum (ER)**. They synthesize, or produce, proteins. The ER is a series of interconnecting flattened tubular channels. The ER takes two forms: rough ER and smooth ER. The smooth ER plays a role in lipid synthesis. The **rough ER** has ribosomes attached and plays a role in protein synthesis and protein folding. Small vesicles containing newly synthesized protein separates from the ends of the rough ER. The vesicles are used to ship them to other parts of the cell or to the outside of the cell. They can also be shipped to the Golgi apparatus for further protein modification, sorting, and packaging. The **Golgi apparatus (Golgi Body)** is a stack of membranous flattened sacs and is directly associated with the endoplasmic reticulum.



Additional organelles include small vacuoles, lysosomes, peroxisomes, and mitochondria. Small vacuoles are involved in storage. **Lysosomes** contain specialized chemical compounds that are necessary for digestion of different chemical compounds in the cell. They also dispose of worn out organelles. Products of their degradation can be reused. Peroxisomes are responsible for protecting the cell as they rid the body of toxic substances such as hydrogen peroxide. Peroxisomes also break down fat. **Mitochondria** are the sites of respiration, and generally are the major energy production center in cells. They produce ATP, the universal energy carrier of cells from organic molecules such as carbohydrates, proteins, and lipids. Cells have cytoskeletal components such as microtubules, actin, and intermediate filaments. These components play numerous roles in the cell such as support, structure, and movement. Lastly, cells have a **cell membrane**. The thin membrane is essential in controlling exchange between the cell and its environment. It acts as a very efficient barrier, but also allows a controlled traffic of materials across it in both directions. The membrane is therefore considered as partially semi-permeable. It allows some materials to pass but not others.

Reflection Questions	
1. What is an organelle?	
2. Based on Sally's symptoms, and the doctor's diagnosis above, which organelle is responsible for Sally's condition?	

Understanding the Structure and Function of the Cell: In order to understand the organization of the cell and remember the various cellular organelles it might be useful to use an analogy. An analogy compares something new with something you already know. Cells are often compared to factories or cities. A factory converts raw materials to useful products much like the cell does. The factory has different components, offices, and staff persons that carry on different functions in order to make the product and keep the factory running smoothly. This is true of the cell as well in that it has different organelles performing different functions. The various organelles all have a specific role in the smooth functioning of the cell. If an organelle of the cell is damaged, the cell can't function properly and it may not function at all. Since the cell is the basic building block of an organism, poorly or non-functioning organelles will impact the health of the entire organism.
"Now I get it! Each cell in our body is like a little factory and the organelles are like parts of the factory. Mitochondria are key organelles that produce energy for the factory to run. Without energy the cellular factories can't function," exclaimed Kenneth.

Reflection Questions	
1. What do you think will happen to the cell and the organism over time if it can't produce energy?	
2. Explain in your own words, in complete sentences, why defects in this energy producing organelle would lead to the symptoms seen in Sally.	

Part IV—Treatment and Prognosis

"The main commonality is all of the mutations and defective proteins affect the energy producing functions of the mitochondria." "You stated that most people with this disorder die within a couple years but some may live longer. Is there anything we can do treatment-wise to prolong her life?" Vicki asked. "Most of the treatments for Leigh Disease are supportive, as there isn't a cure. The main form of treatment includes thiamine or Vitamin B1 supplements. The B vitamins play an important role in metabolism of carbohydrates into cellular energy, the main process affected in people with Leigh Disease. It may also strengthen the immune system and improve the body's ability to withstand stress," the doctor explained. In addition to what I've mentioned, other treatment goals will include providing relief from specific symptoms such as reducing lactic acid build-up, controlling seizures, reducing nausea, and reducing vomiting. It is important that you take as many precautions as reasonably possible to minimize Sally's exposure to other people who are sick with colds and other contagious illnesses as illness will worsen Sally's illness," the doctor explained.

"I just can't believe how one tiny defective cell part can be so catastrophic! Are there other examples of defective cellular organelles causing disease?" asked Kenneth. "Yes. There are a whole host of disorders caused by defective cellular organelles," replied the doctor. He then went on to name some along with their symptoms.

Reflection Questions	
Summarize the treatment and care for someone with Leigh's disease. What is the primary treatment for Leigh Disease?	