



Organelle Ailments

Submitted by: Lauren Wilmoth, Biology
Oak Ridge High School, Oak Ridge, TN

Target Grade: Middle School Life Science and High School Biology

Time Required: 45-90 minutes

Standards

Next Generation Science Standards (NGSS):

- MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Lesson Objectives

Students will:

- Be able to match each organelle with its function, picture, and a scenario describing a medical condition caused by a malfunctioning organelle.
- Evaluate the importance of each organelle using medical scenarios for evidence to support their claim.

Central Focus

The lesson will begin with a quick review of the functions of each of the major cell organelles. Students will then complete a card sort in which they will read medical scenarios to determine which organelle's malfunction is responsible for the patient's symptoms. In addition, they will also match each organelle with its corresponding picture and function. Finally, students will use the medical scenarios and their background knowledge on the function of each organelle to make an argument (claim-evidence-reasoning) about which organelle is most important.

Key terms: real world scenario, matching, model, cells, organization, interactions, systems, evaluate, support



Background Information

Students should be familiar with the functions of the major organelles prior to this lesson. Additionally, teacher may want to become more familiar with each of the disorders listed in the table below.

Organelle	Disease
Nuclear Envelope	Progeria
Cilia	Respiratory Infection/COPD
Flagella	Multiple Morphological Abnormalities of the Flagella (MMF)
Cytoskeleton	Hereditary Elliptocytosis
Plasma Membrane	Myotonia Congenital
Lysosome	Tay Sachs
Mitochondria	Mitochondrial Myopathy
Golgi Apparatus	Achondrogenesis 1a
Ribosomes	Treacher Collins

Students may need to be reminded that any discussion of human diseases is a sensitive subject. It is important for students to be aware that other classmates may know someone or be personally affected by discussed diseases.

Students will be able to complete the final portion of this lesson if they have been taught how to complete a claim-evidence-reasoning writing prompt in the past. However, prior exposure to this type of writing is not necessary to complete this lesson. If students are unfamiliar with claim-evidence-reasoning, they may require more scaffolding (see differentiation section).

Materials

- Card Sets (Printed in Color and Cut out Individually) – 1 set per 3 students
- Liquid chalk markers (*not required)

Instruction

Introduction (5 minutes):

- Have students try to define/describe each of the following organelles using just one word: Golgi body, ribosome, chloroplast, mitochondria, vacuole, cytoplasm, nucleic acids, vesicle, nucleolus, nucleus, lysosome, cell wall, cell membrane, centriole, and smooth endoplasmic reticulum.



- Go over students' answers. Some organelles may be very difficult to describe/define in one word. Allow students to expand to two words if they have struggled with it for a sufficient amount of time (approximately one to two minutes).

Activities (40 minutes):

- Go over the objectives with the students. Explain that they will use their knowledge of organelles to determine how malfunctions in various organelles can cause health impairments.
- Assign student groups of approximately three students per card set. Let the students know that they must match the name of the organelle (red card), with its corresponding picture (green card), function (yellow card), and finally patient/disorder (blue card) to make a large information table on their lab bench. If liquid chalk markers are available, allow the students to draw the table on their lab bench to sort their cards.
- Check each group's work, and have students look again if they made a mistake.
- Next, have students rank the disorders/ailments from "most harmful" to "least harmful." This is subjective so there is no right or wrong answer.

Closure (15 minutes):

- Have the groups answer the following writing prompt using claim-evidence-reasoning criteria: "Which of the following organelles is most important: nuclear envelope, cilia, flagella, cytoskeleton, plasma membrane, lysosomes, mitochondria, Golgi apparatus, ribosomes".
- Students should provide evidence and reasoning from the cases to support their claim.
- Once teams have completed the prompt, facilitate a discussion/debate about which organelle is the most important.

Extensions:

- Have students supplement their writing prompt by using text and/or online resources to learn more about the importance of each organelle in the body.
- Have students complete more detailed research projects about each of the diseases discussed in the card sort.

Organelle	Disease
Nuclear Envelope	Progeria
Cilia	Respiratory Infection/COPD
Flagella	Multiple Morphological Abnormalities of the Flagella (MMF)
Cytoskeleton	Hereditary Elliptocytosis
Plasma Membrane	Myotonia Congenital



Lysosome	Tay Sachs
Mitochondria	Mitochondrial Myopathy
Golgi Apparatus	Achondrogenesis 1a
Ribosomes	Treacher Collins

Differentiation

- To help students build a table for the card sort, teacher may project or draw an example table on the board. If students need even more guidance, teacher may pre-draw tables for students.



- If students are overwhelmed by the number of cards and the various card types, the teacher may provide the organelle name and picture cards first for students to match. Then after verifying accuracy, the teacher may provide the function cards. After checking the function accuracy, the teacher can provide the disease/patient cards.
- The teacher may highlight key words in disease/patient cards prior to printing, or provide students with a yellow dry erase marker (if cards are laminated) so students can highlight key information to help them determine which patient/disease card goes with which organelle.
- The teacher may provide more scaffolding for the claim-evidence-reasoning writing prompt by providing a with additional guidance such as:



State your claim: We think that _____ is the most important organelle.

Evidence: Please describe the evidence you have to back up your claim above.

Reasoning: Elaborate on your evidence and describe why other organelles are not as important (defend against counter arguments).

Assessment

Formative Assessment:

- Students will be assessed individually by their ability to complete the bell work assignment.
- Student groups will be assessed informally by their ability to complete the card sort with minimal hints/redirection from the teacher.

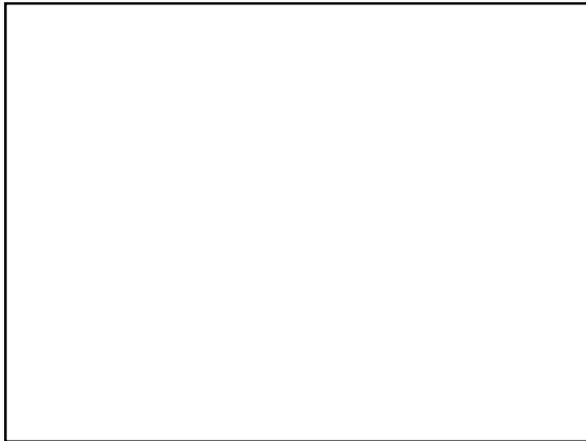
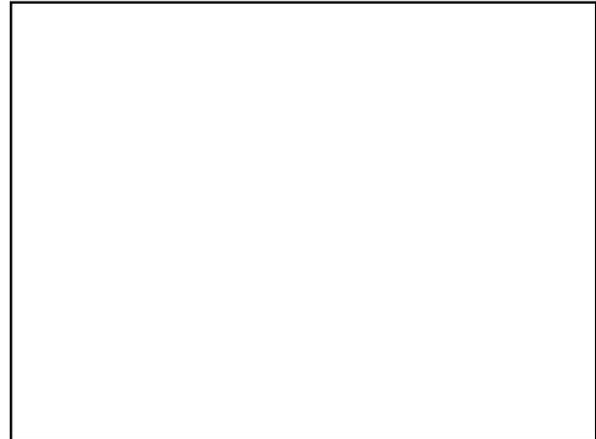
Summative Assessment:

- Students' written claim-evidence-reasoning statement that uses evidence from the card sort will serve as a formal assessment. There is no right or wrong answer for this assessment, but rather students will be assessed on their ability to use evidence about organelle disease to support their claim effectively.

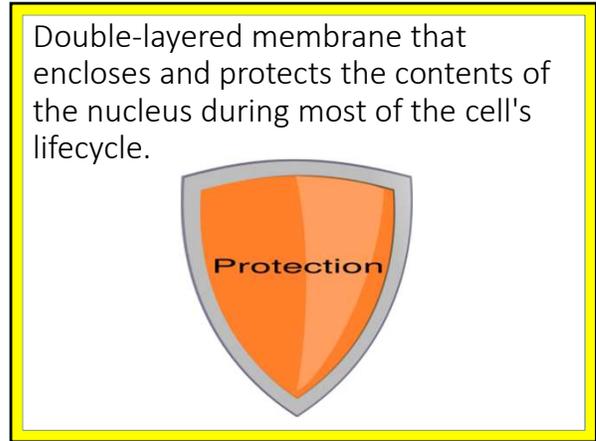
Patient #1: Jackie

Jackie was a healthy baby when she was first born, but after 4 months, she had gained little weight. Her parents suspected something was seriously wrong. Her head became disproportionately large for her face. She experienced hair loss, and her skin became thin and wrinkled. Jackie's doctors told them that the condition was progeria which occurs when the genetic material doesn't have proper protection.

This disease is incredibly rare. It affects only one in every 4-8 million births. It is caused by a mutation in a gene called LMNA, but is not hereditary. This disease causes premature aging. People with progeria have an average life expectancy of 14 years and usually die from heart disease related to their "aging" body.



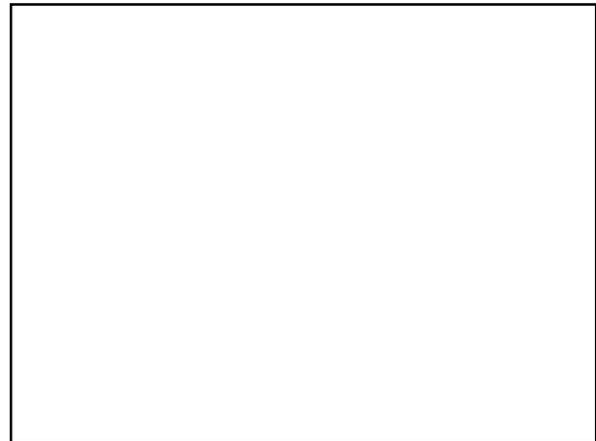
Double-layered membrane that encloses and protects the contents of the nucleus during most of the cell's lifecycle.

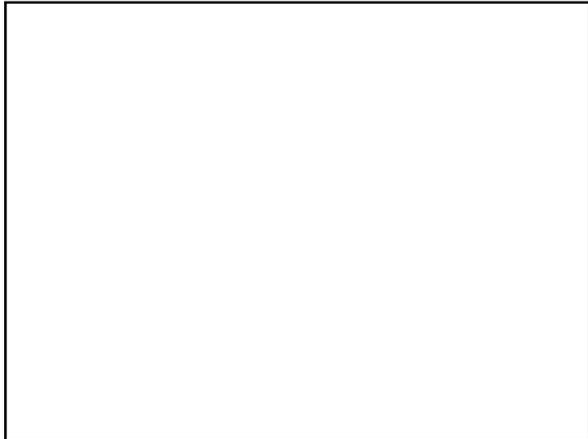


Patient #2: Fiona

Fiona is a freshmen in college. She is a good student who does her work on weekdays and likes to party on the weekends with her friends. A few months ago, Fiona developed a **cough that wouldn't go away and worsened over time. She has also had difficulty breathing over the past week or so.** Her friends encouraged her to see the doctor, so she finally made an appointment. The doctor asked her whether or not she smoked cigarettes. Fiona responded that she started smoking cigarettes (about 2 per day) her freshman year of high school.

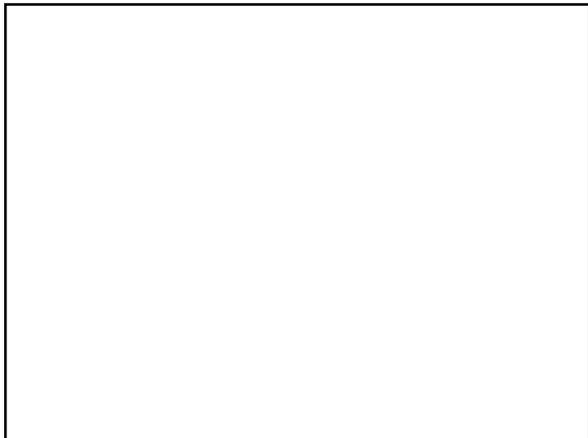
The doctor decided it was necessary to take a biopsy of the cells that line the bronchus (passageway to the lungs). After several days, the biopsy report has come back along with a micrograph of the bronchial cells. **Fiona's cigarette smoking has badly damaged these organelles which are responsible for mucus and dirt moving up and out of her respiratory system. What cell organelles have been damaged?**



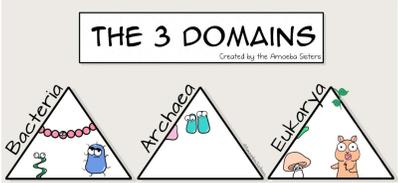


Small hair-like protuberances on the outside of eukaryotic cells. They are primarily responsible for locomotion, either of the cell itself or of fluids on the cell surface.

Patients #3: Zeke and Morgan
 Zeke and Morgan have lived in Vermont most of their lives. They are both in their late 20's and recently married. They have been trying to have their first child for a number of months but Morgan has been unable to get pregnant. Zeke and Morgan decided to go to their family physician to see if there may be something wrong. The physician obtained a sample of Zeke's sperm cells and had it sent to a lab for microscopic analysis. After several days, the physician received a micrograph of the sperm cells and noted a structural defect in the organelle responsible for cell movement. Help determine the organelle responsible for Zeke and Morgan's inability to have a baby.

Long, whip-like filamentous protein structures found in bacteria, archaea, and eukaryotes, though they are most commonly found in bacteria. They are typically used to propel a cell through liquid.

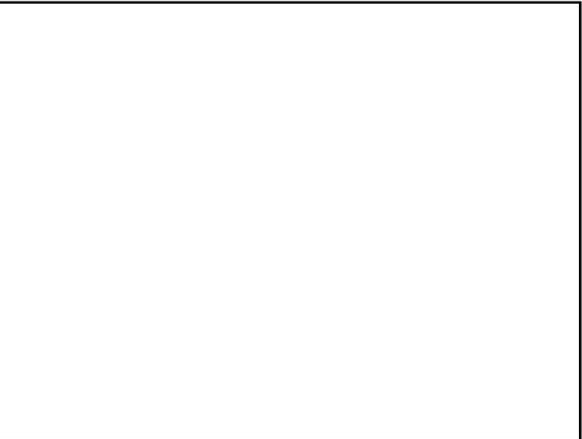
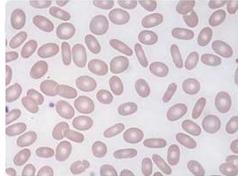


THE 3 DOMAINS
Created by the Amoeba Sisters

The diagram illustrates the three domains of life: Bacteria (represented by a blue rod-shaped bacterium), Archaea (represented by a pink rod-shaped archaeon), and Eukarya (represented by a green eukaryotic cell with a nucleus and a red flagellum). Each domain is shown within a triangle pointing upwards.

Patient #4: Trevor

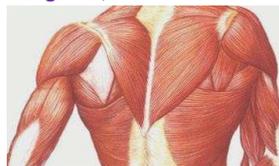
Trevor is a 20-year old male who has suffered from repeated episodes of hemolytic anemia. During these episodes, Trevor's red blood cell counts drop off dramatically due to rupturing of large numbers of cells and the inability of his bone marrow to replace the ruptured cells fast enough. When Trevor comes into a clinic for treatment, he is diagnosed initially with a hereditary deficiency in the enzyme glucose-6-phosphate dehydrogenase, but biochemical tests rule this out. An examination of his blood reveals that many of his red blood cells have an elliptical shape which leads to the diagnosis of **hereditary elliptocytosis**. structures within the red blood cells alter the shape of the cell from the normal biconcave, disc shape to an elliptical shape, causing premature damage and rupture of the cells.

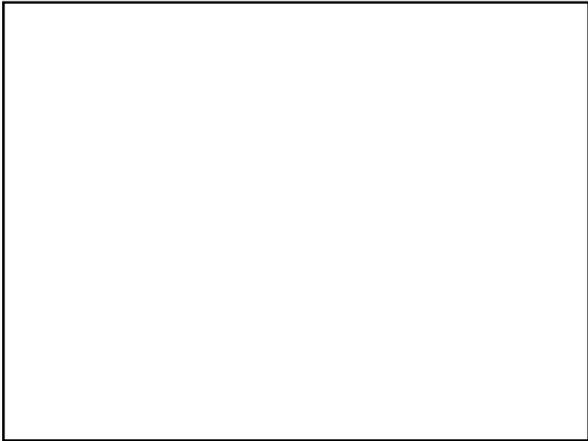


Provides support in a cell. It is a network of protein fibers supporting cell shape and anchoring organelles within the cell.

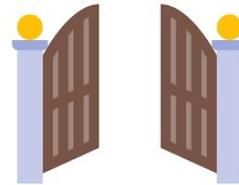
Patient #5: Rosanna

Rosanna is a 39-year old woman who comes to visit an urban New York City clinic. Despite rarely working out, she has a very muscular build, suggesting a hypertrophy (enlargement) of her muscles. She has suffered from bouts of extreme muscle stiffness, especially in her legs, and often brought on by cold weather throughout her life. Her father and paternal grandmother also had these symptoms. After genetic screening and biochemical tests, the doctors determine that she is suffering from **myotonia congenita**, a "channelopathy" involving a malfunction of chloride channels, which regulate the movement of chloride ions between the outside and inside of the cell.



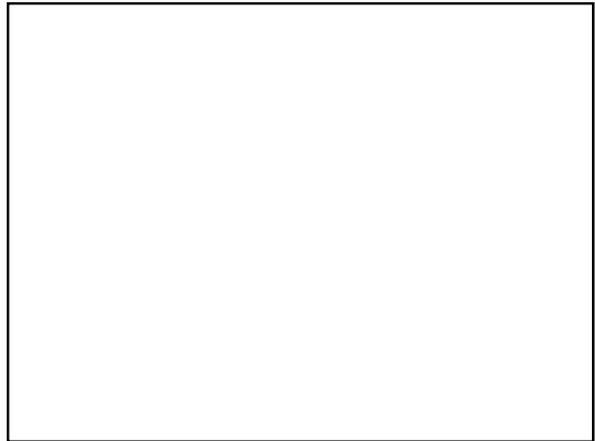
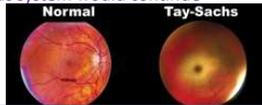


The border between the interior and exterior of a cell. It controls passage of various molecules—including sugars, amino acids, ions, and water—into and out of the cell.

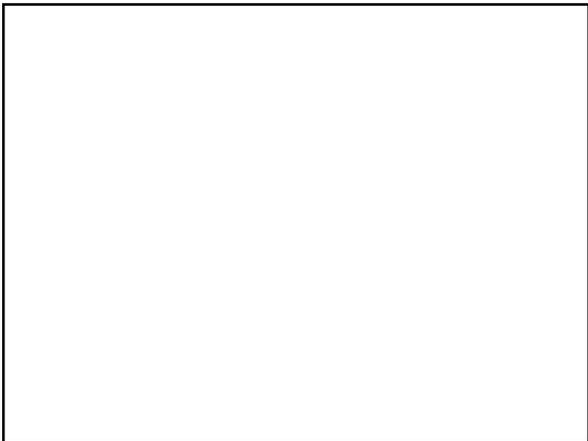
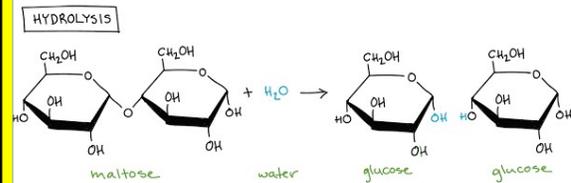


Patient #6: Harvey

Harvey was a perfectly happy baby with normal development until about six months of age. He had learned to roll over and sit up for a few seconds, but then was suddenly unable to do either of these things. He stopped turning and smiling at his mother's voice as he had before, and he did not seem as interested in his toys as he once was. Harvey's parents took him to the doctor because they were concerned about these changes. It took exams by several specialists to diagnose Harvey's Tay-Sachs disease. This disease has become very rare (fewer than ten cases appear each year) in large part due to screening programs in population groups known to have this inherited illness. Harvey's parents were not among those ethnic groups most at risk. Also, they had no idea that they both were carriers of the gene that causes this very rare illness. A neurologist verified her hypothesis of Tay-Sachs by looking into Harvey's eyes, where she saw the telltale cherry red spot indicating the illness. There was a build up fatty material on his nerve cells that his cells couldn't break down. His nervous system would continue to fail, and he would be paralyzed and unable to see or hear by the time he died before the age of four.

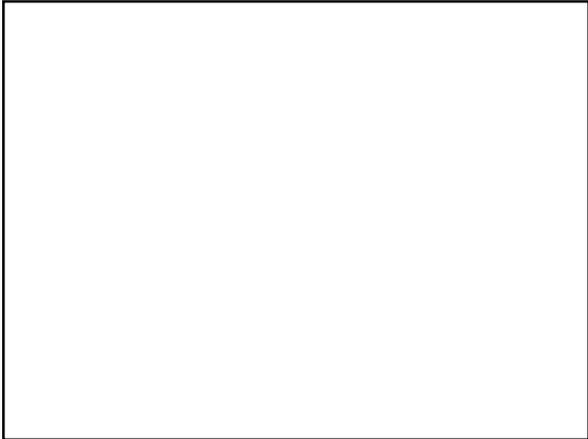
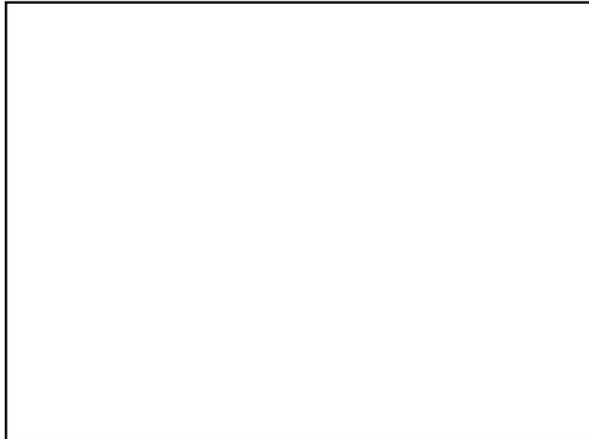


A vesicle that contains hydrolytic enzymes that can break down many kinds of biomolecules.

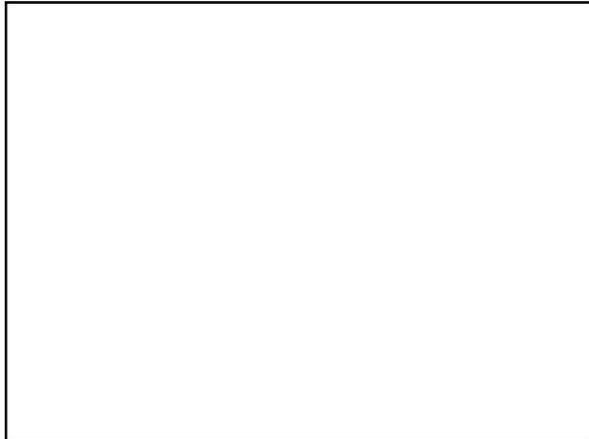
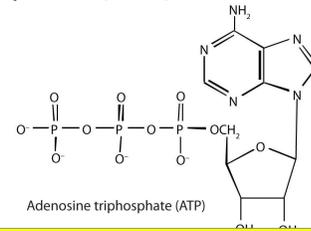


Patient #7: Kathy

Kathy is a fifteen-year-old soccer player at a nearby high school. She arrived in the ER at 6:07 p.m. She was experiencing extreme muscle weakness and loss of muscle coordination, particularly in her arms and legs! She told the doctors that for the past few days, she had been extra tired with little energy to do anything. The doctors decided to do some blood work which showed one particular abnormality. Kathy's glucose levels were rather high although she was an athlete and did mention she usually ate carbohydrates the night before a game. However, this explanation could be dismissed since she did not have a game in the past week. The doctors agreed that something else must be going on to cause such high glucose levels (i.e. something was not breaking down sugar molecules). The doctors ordered for a muscle biopsy to be performed. The doctors viewed the tissue sample under the microscope, and saw that the muscle fibers were ragged red which contained mild accumulations of glycogen and decreased activity for the enzyme cytochrome c oxidase.

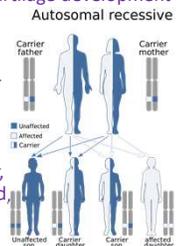


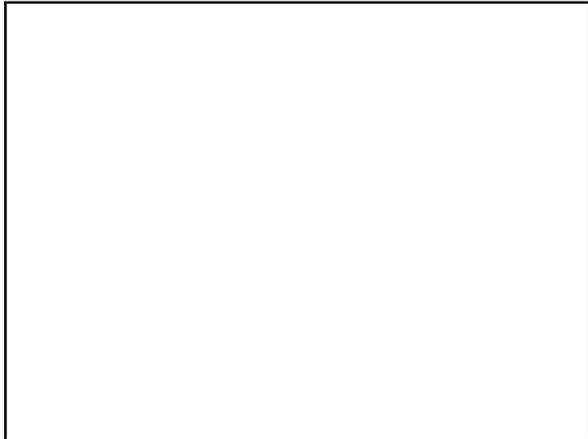
Rod-shaped organelles that can be considered the power generators of the cell, converting oxygen and nutrients into adenosine triphosphate (ATP)



Patient #8: Lucy and Jim

Lucy and Jim have been married for 5 years and have decided they would like to try to have a child. However, a rare genetic disorder runs in both of their families, so they decide to go to a genetic counselor to determine the chances that their future child will be affected. The disease achondrogenesis 1a affects the ability of proteins necessary for bone and cartilage development to be modified and packaged properly after leaving the endoplasmic reticulum. The results are devastating. Individuals with this disorder are often stillborn or die soon after birth from respiratory failure. Fortunately, after doing a genetic screening, the genetic counselor determined that while Jim is a carrier for this autosomal recessive disorder, Lucy is not. Therefore, if they do have a child it is unlikely that their child will be affected.

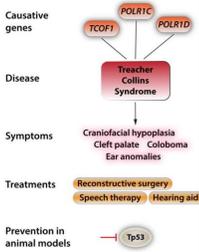
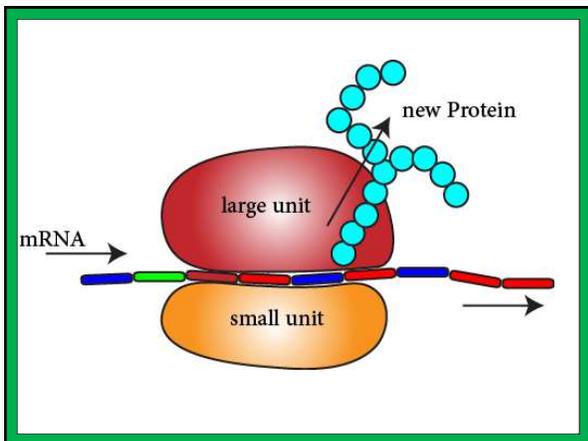




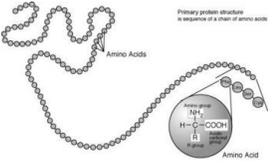
Gathers simple molecules and combines them to make molecules that are more complex. It then takes those big molecules, packages them in vesicles, and either stores them for later use or sends them out of the cell. It is also the organelle that builds lysosomes.



Patient #9: Vera
 When Vera came home from her first day of kindergarten, she was very upset. She always knew she was different, but she had never been around this many new people who were staring and whispering. Vera was born with Treacher Collins syndrome. She has it because there is a mutation in her DNA that codes for the part of the cell responsible for assembling proteins. Because these cells are unable to make proteins, they undergo apoptosis (programmed cell death). Doctors don't know why but this cell death occurs only in the cells necessary for the development of facial bones and tissues. Even though Vera has had several plastic surgeries in her life to make her appearance less affected by the disease, she continues to have distinct facial characteristics, such as underdeveloped cheek bones, unusually formed ears, and a very small jaw and chin.

Link amino acids together in the order designated by the mRNA to create proteins, can be found floating free in the cytoplasm or attached the endoplasmic reticulum.



Name of Organelle	Picture	Function	Patient/Disease
Nuclear Envelope		Double-layered membrane that encloses and protects the contents of the nucleus during most of the cell's life cycle.	Patient #1 Jackie Progeria
Cilia		Small hair-like protuberances on the outside of eukaryotic cells. They are primarily responsible for locomotion, either on the cell itself or of fluids on the cell surface.	Patient #2 Fiona Cough from smoking/COPD
Flagella		Long, whip-like filamentous protein structures found in bacteria, archaea, and eukaryotes, though they are typically used to propel a cell through liquid.	Patient #3 Zuke and Morgan Infertility/MNF
Cytoskeleton		Provides support in a cell. It is a network of protein fibers supporting cell shape and anchoring organelles within the cell.	Patient #4 Trevor Hereditary Elliptocytosis
Plasma Membrane		The border between the interior and exterior of a cell. It controls passage of various molecules – including sugar, amino acids, ions, and water – into and out of the cell.	Patient #5 Rosanna Myotonia Congenita
Lysosome		A vesicle that contains hydrolytic enzymes that can break down many kinds of biomolecules.	Patient #6 Harvey Tay Sachs
Mitochondria		Rod-shaped organelles that can be considered the power generators of the cell, converting oxygen and nutrients into adenosine triphosphate (ATP).	Patient #7 Kathy Decreased Cytochrome C Oxidase/Myopathy
Golgi		Gathers simple molecules and combines them to make molecules that are more complex. It then takes those big molecules, packages them in vesicles, and either stores them for later use or sends them out of the cell. It is also the organelle that builds the lysosomes.	Patient #8 Jim and Lucy Achondroplasia 1a
Ribosomes		Link amino acids together in the order designated by the mRNA to create proteins, can be found floating free in the cytoplasm or attached to the endoplasmic reticulum.	Patient #9 Vera Treacher Collins