



MISSING PUZZLE PIECES: CLEFT LIP AND PALATE

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YOUNG REVIEWERS:



CARINA

AGE: 13



ERICA

AGE: 12



KALLIE

AGE: 13



SCIENCE
CLUB OF
ESCOLA
CONCEPT
RIBEIRÃO
PRETO

AGE: 10

TISSUES

Groups of cells that work together to do specific jobs.

Facial differences can arise while a baby is still growing inside the mother. Two common examples include cleft lip and cleft palate. Most of the body's cells contain DNA, which serves as the instructions for creating all the features of the body, such as the parts of the face. Cells use DNA's instructions to form the face from five big "puzzle pieces" called prominences. Sometimes the DNA instructions get changed or steps are skipped, which can change how the puzzle pieces, or prominences, connect. This results in facial differences like cleft lip, in which there is a gap in the lip and cleft palate, in which there is a gap in the roof of the mouth. Most cases of cleft lip and cleft palate can be fixed with surgery, and children go on to live long, healthy lives.

WHAT ARE CLEFT LIP AND CLEFT PALATE?

The human face is made up of millions of cells. Cells come together to form clumps called **tissues** that create the various parts of the face, including the eyes, ears, nose, and mouth. When a baby is growing

FACIAL DIFFERENCES

Variations in the way that facial features like the eyes, ears, nose, and mouth come together and appear to others.

CLEFT LIP

Small opening or gap in the upper lip that can happen when a baby is growing inside their mother's stomach before they are born.

CLEFT PALATE

An opening in the roof of the mouth that can happen when a baby is growing inside their mother's stomach before they are born.

Figure 1

Different types of cleft lips and palates shown on a newborn baby. **(A)** Normal lip and palate, which extends to the back teeth on an adult. **(B)** Cleft palate, in which there is an opening in the roof of the mouth. **(C)**

Combined cleft lip and palate on the left side, which is caused when there is an opening in the lip and roof of the mouth on the left side. **(D)** Cleft lip and palate on both sides, caused when there are openings on both sides of the top lip and the roof of the mouth.

inside the mother, the parts of the face are formed. Sometimes, however, the parts of the face can grow in unusual ways. When this happens, people can be born with **facial differences**. Two common examples of facial differences are called **cleft lip** and **cleft palate**.

Look at your reflection and imagine that your top lip was not connected at the center. It does not hurt like a cut, but there is an open space. You can see inside your mouth, the tops of your teeth, and inside your nose. This is called cleft lip, and it happens when a baby's lips form differently before they are born. Now, use your tongue to feel the shape of the roof of your mouth, going from your two front teeth to the teeth all the way to the back. This part of your mouth is called your palate. When there is a space on the roof of the mouth, where it would usually be solid, this is called a cleft palate. Cleft palate happens when the roof of a baby's mouth forms differently before they are born (Figure 1).

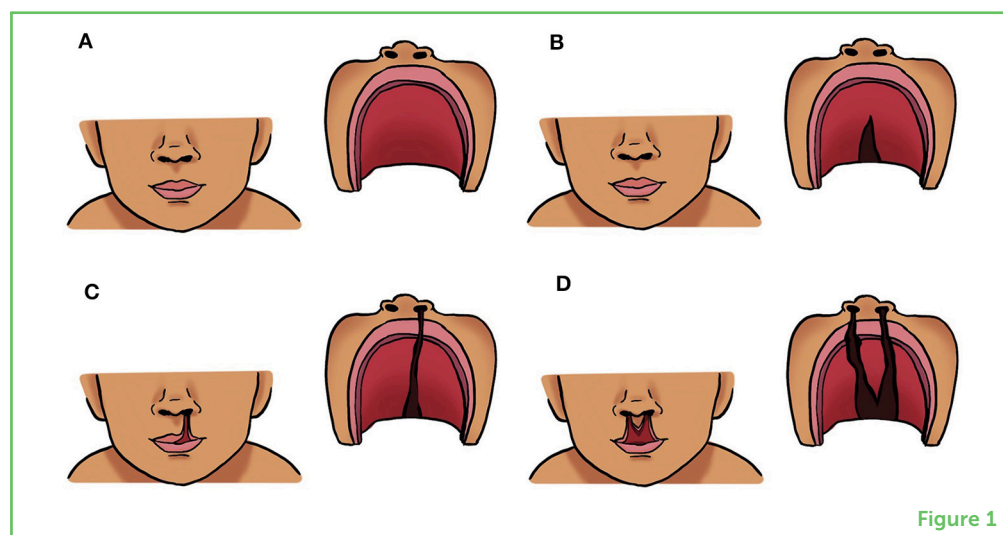


Figure 1

Cleft lip and palate are relatively common—every 3 min, a child is born with a cleft lip, cleft palate, or both. Cleft lip is more common than cleft palate. For every 1,000 new babies born, there is 1 baby born with a cleft lip [1]. You may know a friend or family member who had a cleft lip or palate. Despite being so common, these conditions are generally not seen very often because they are usually fixed when children are very young.

HOW DO CLEFTS FORM?

Nearly every cell in the human body contains instructions in the form of *DNA*. If you imagine the body as a puzzle, the instructions in the DNA help the body know where to put the pieces as it grows. There are sections of DNA that specifically tell the body's cells where parts of the face should go.

PROMINENCES

The building blocks that create a baby's face before birth.

Prominences eventually become facial features such as the forehead, nose, cheeks, and chin.

A baby spends about 9 months inside the mom, growing from a single cell. Groups of cells use the DNA's instructions to come together and form five major **prominences**, which are like the puzzle pieces that eventually form the face. The first piece is the forehead, which grows and supports the rest of the features. The second piece forms the lower part of the mouth and chin. The third piece forms both sides of the upper lip and cheeks. Finally, the fourth and fifth small pieces connect to form each half of the nose (Figure 2). Inside the mouth, these pieces also connect to form the palate, which separates the inside of the mouth from the inside of the nose [2]. Sometimes these pieces get the wrong instructions about where to go or how to connect. They come together differently, or fail to connect at all, leaving a gap called a cleft. Clefts can be on one side of the face or on both sides. The gaps can be big or small and can include just the lips, just the palate, or both (Figure 1) [3].

Figure 2

(A) The parts of the human face can be thought of as puzzle pieces that must come together to make a whole picture. In an unborn baby, the original pieces, called prominences, connect to form the forehead (green), the cheeks (blue), both halves of the nose (yellow and pink) and the chin (purple). (B) When there is a mismatch in the puzzle pieces and they do not come together properly, a cleft can form.

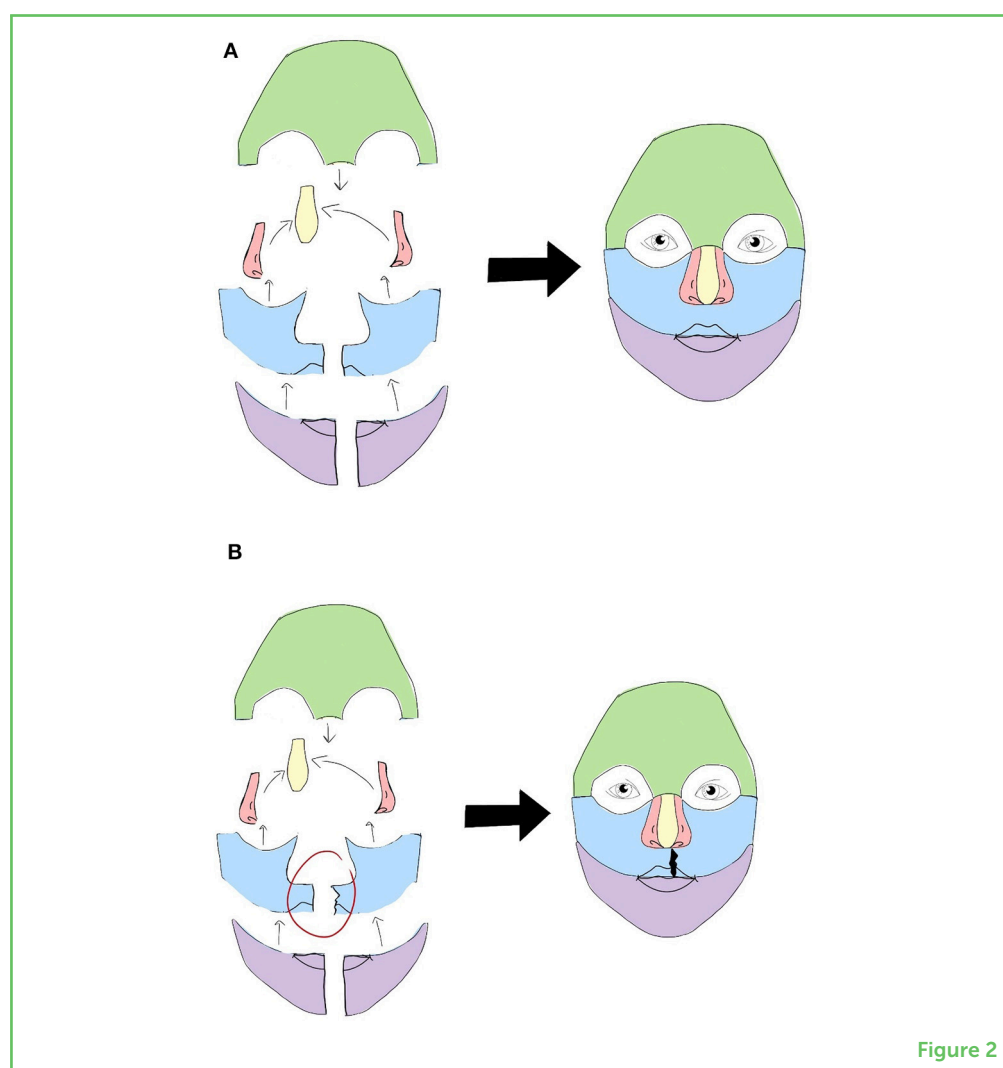


Figure 2

MUTATION

A change to the DNA that causes cells to grow, move, or function differently. Mutations can create differences in facial features, hair color, or eye color.

SEIZURES

Sudden, unexpected electrical activity in the brain that can make a person's body shake or act differently for a short time.

PLASTIC SURGEONS

Doctors who repair and rebuild visible parts of the body. They perform surgeries to repair facial differences.

WHAT CAUSES CLEFT LIP AND CLEFT PALATE?

There are many ways that the facial prominences can connect differently, forming a cleft lip or cleft palate. Some kids have a family history of cleft lip or palate, which makes them more likely to have it, too [4]. Everyone inherits features from their parents, and this is because we inherit our parents' DNA. Perhaps you have been told that you have your mother's eyes, your father's hair, or your grandmother's nose. Sometimes, people can inherit facial differences too, and this can be due to changes in the DNA called **mutations**. DNA mutations can change the way cells move and grow, like a list of instructions with some steps missing or changed. When there are certain DNA mutations, some of the puzzle pieces might not know where to go or how to connect to each other.

Cleft lip and palate can also be caused by things the mother is exposed to during pregnancy. A growing baby gets all its oxygen, water, and nutrients from the mother. Therefore, if a pregnant woman is exposed to a certain substance, it may affect the baby's growth, even if the mother does not know it [5]. Sometimes women need to take medicine for their own health, and the medicine can cause a cleft lip or palate in their child. One example is the drug carbamazepine, which many people take to prevent **seizures**. When women taking such medications want to get pregnant, their doctors must keep a very close eye on the baby before and after it is born, to see if it is growing properly. If the baby appears to have a cleft lip or cleft palate, surgeons can make plans to repair it.

HOW DO DOCTORS REPAIR CLEFT LIP AND CLEFT PALATE?

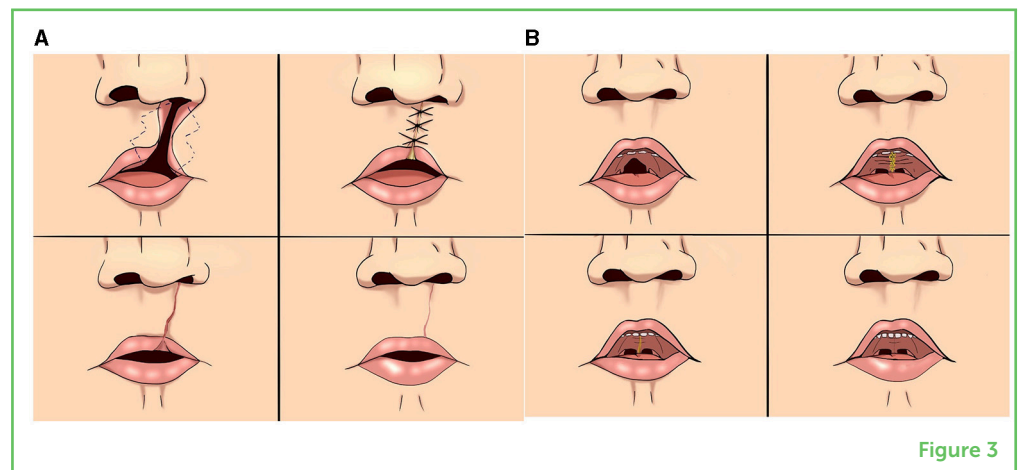
People born with cleft lip or palate need to be watched closely by many doctors, because the clefts can have a big impact on how they grow up. The mouth, nose, and ears are all connected, so when one part develops differently, it can affect the rest. People with cleft lips or palates can grow up with difficulties eating, sleeping, hearing, and even breathing. Large clefts can create a pathway from the mouth to the nose where one should not be, so food and drinks can go down the wrong way from the nose to the throat and lungs instead of to the stomach! Some people with a cleft lip or palate can eat or drink normally, but others might have difficulty. Doctors might give parents special equipment to help their children eat, such as special bottles that cover the cleft and make sure the milk goes down to the stomach.

Some people spend their whole lives with open clefts, but today, many people get their clefts closed through surgery when they are less than a year old. The operation is performed by a **plastic surgeon**—a surgeon who specializes in repairing and rebuilding all parts of the human body, including the face. During the surgery, the child is put to sleep for

1–3 h. To repair a cleft lip, the surgeon carefully cuts into the skin and muscles around the space, pulls them together, and sews them tight. There is enough surrounding skin and muscle to fill in the missing puzzle pieces of the lip. This leaves a small scar between the person's lip and nose (Figure 3). To repair a cleft palate, the surgeon makes the cut on the palate and pulls the pieces together to close the cleft. In this case, the scar is inside the mouth and not outwardly visible.

Figure 3

(A) The surgery and healing process for cleft lip. The surgeon uses the lips, muscles, and skin around the space and sews the pieces together to close the cleft lip. Over time, the area heals and forms a light scar on the upper lip. (B) The surgery and healing process for cleft palate. The surgeon uses the bone and soft tissue around the space and sews the pieces together to close the cleft palate. Over time, the area heals and forms a light scar inside the mouth.



Although cleft lip and palate surgeries only leave a small scar that is not always seen on the outside, people with cleft lip and palate may need other care throughout childhood. After surgery, a person born with a cleft lip or palate may find that their face develops differently as they grow up, and they might need interventions such as braces and follow-up surgeries. They might see a speech therapist if their mouth cannot make certain sounds. They may even need to see a counselor if they get teased or bullied.

CONCLUSION

The human face is made of millions of cells that grow, rearrange themselves, and combine to form the pieces that become the eyes, ears, nose, and mouth. When the pieces of the lips and mouth come together differently or do not connect at all, a person is left with facial differences such as cleft lip or cleft palate. This can happen for a few reasons, including DNA mutations and exposure to certain substances during pregnancy. People who are born with clefts often get surgery to close them and will be monitored by doctors for a long time. But regardless, they will go on to lead long, healthy lives. All puzzles are different, and faces can be, too! Regardless of their differences, the pieces come together to create something beautiful that should be appreciated and respected.

REFERENCES

1. Mai, C. T., Isenburg, J. L., Canfield, M. A., Meyer, R. E., Correa, A., Alverson, C. J., et al. 2019. National population estimates for major birth defects, 2010–2014. *Birth Defects Res.* 111:1420–35. doi: 10.1002/bdr2.1589
2. Ansari, A., and Bordoni, B. 2023. *Embryology, Face*. Treasure Island, FL: StatPearls Publishing. Available online at: <https://www.ncbi.nlm.nih.gov/books/NBK545202/> (accessed May 8, 2022).
3. Alois, C. I., and Ruotolo, R. A. 2020. An overview of cleft lip and palate. *Off. J. Am. Acad. Phys. Assist.* 33:17–20. doi: 10.1097/01.JAA.0000721644.06681.06
4. Walker, N. J., Anand, S., and Podda, S. 2022. *Cleft Lip*. Treasure Island, FL: StatPearls Publishing. Available online at: <https://www.ncbi.nlm.nih.gov/books/NBK482262/> (accessed May 15, 2022).
5. Antiguas, A., Paul, B. J., and Dunnwald, M. 2022. To stick or not to stick: adhesions in orofacial clefts. *Biology* 11:153. doi: 10.3390/biology11020153

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YOUNG REVIEWERS

CARINA, AGE: 13

My name is Carina and I am 13 years old. I have many interests including soccer, music, reading, math, and science. I find science very fascinating, especially biology. My dream is to work in medicine. I am very interested in how our bodies work well and malfunction; I want to help people in the future achieve their best health. I am quite intrigued about how technology will improve our abilities to detect illness earlier and track how well therapies are working.





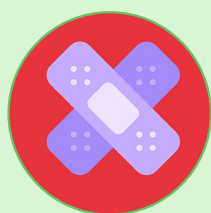
ERICA, AGE: 12

My name is Erica and I am 12 years old. I love video games, science and judo. My favorite game is Zelda, and I want to become a game director someday. In science, I like questioning new information and trying to figure out things I do not know based on what I do know. I also play judo, and I am currently an orange belt.



KALLIE, AGE: 13

My name is Kallie and I am 13 years old. I enjoy playing lacrosse on my team! I enjoy learning about neuroscience and I am interested in iPS cells. I participate in debate workshops. Some of my other hobbies are painting, reading, using Pinterest, and creating digital art! I am fascinated by butterflies, and all cats big and small. I am a member of my school's student council and school council. I love writing poetry and even won an award for one of my poems.



SCIENCE CLUB OF ESCOLA CONCEPT RIBEIRÃO PRETO, AGE: 10

We are the Science Club of Escola Concept Ribeirão Preto! Our names are Carolina, Catarina, Lívia, Nicolas, Pedro 1, and Pedro 2. We are proud 5th and 6th-grade students passionate about science. Chosen for our excellent results in science assessments and competitions, we are curious, avid readers of the magazine, and excited to dive into the article review process. We are thrilled about this scientific journey full of discoveries and laughter!

AUTHORS



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Hannah is a 1st-year medical student at the University of Limerick, School of Medicine, originally from southern Ontario, Canada. She loves working with children and has spent many years as an ice-skating coach and camp counselor. She is a part of the Pediatric Society and Teddy Bear Hospital and has organized educational initiatives for children in the community. She aspires to work in pediatric medicine and is passionate about promoting health equity. In her free time, Hannah enjoys reading and ice skating. *22183612@studentmail.ul.ie



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Brynn is a 1st-year medical student at the University of Limerick from Newcastle, Ontario, Canada. She has a love for working with children and decided to get involved in the Pediatric Society at school to continue to explore this passion and work on projects like this article. Brynn fills most of her free time playing sports, particularly hockey, running, and cycling.



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Hailing from Toronto, Canada, Danica is a 3rd-year medical student at the University of Limerick School of Medicine. She has been involved in the Pediatrics Society at her school, creating posters, logos, and advertisements for events, and educational videos for kids. One day, she wants to work in pediatric medicine or surgery and help improve medical accessibility among children and teens. When not studying, Danica loves swimming, kayaking, reading every book she can get her hands on, and drawing characters for stories, old and new.



DAMIR MATIC

Dr. Matic finished residency training at the University of Toronto. He completed specialty training in craniomaxillofacial surgery at Johns Hopkins Hospital. He is currently an associate professor within the Division of Plastic Surgery at Western University. He is also works in the Department of Pediatrics and Otolaryngology. His primary interests are cleft lip and palate, pediatric craniofacial surgery, and facial nerve reconstruction. Dr. Matic completed a Master of Science in the Department of Medical Biophysics. His current research interests include facial growth and the long-term analysis of cleft lip repair and muscle movements of the mouth.