What causes Down syndrome?

Down syndrome is caused by a random error in cell division that results in the presence of an extra copy of chromosome 21.

The type of error is called nondisjunction (pronounced *non-dis-JUHNGK-shuhn*). Usually when one cell divides in two, pairs of chromosomes are split so that one of the pair goes to one cell, and the other from the pair goes to the other cell. In nondisjunction, something goes wrong and both chromosomes from one pair go into one cell and no chromosomes for that pair go into the other cell.

Most of the time, the error occurs at random during the formation of an egg or sperm. To date, no behavioral activity of the parents or environmental factor is known to cause Down syndrome.

After much research on these cell division errors, researchers know that:

- In more than 90% of cases, the extra copy of chromosome 21 comes from the mother in the egg.
- In about 4% of the cases, the father provides the extra copy of chromosome 21 through the sperm.
- In the remaining cases, the error occurs after fertilization, as the embryo grows.

The NICHD launched DS-Connect® as a safe and secure online registry for people with Down syndrome, their families, and researchers to share information and participate in clinical trials or research. As the registry grows, families and researchers learn more about Down syndrome and identify similarities and differences in the symptoms and treatment of people with Down syndrome from around the world. The information collected helps guide future research and treatment.

Chromosomal Changes That Can Cause Down Syndrome

Research shows that three types of chromosomal changes can lead to Down syndrome.

- **Complete trisomy 21**. In this case, an error during the formation of the egg or the sperm results in either one having an extra chromosome. So after the egg and sperm unite, the resulting cells will also have three copies of chromosome 21. The complete extra copy of chromosome 21 is in all of the person's cells—or a complete trisomy. Complete trisomy 21 is the cause of about 95% of Down syndrome cases.
- **Mosaic trisomy 21**. Not every cell in the body is exactly the same. In about 1% of Down syndrome cases, most of the cells in the body have the extra chromosome, but some of them don't. This is called "mosaicism." Mosaic trisomy 21 can occur when the error in cell division takes place early in development but after a normal egg and sperm unite. It can also occur early in development when some cells lose an extra chromosome 21 that was present at conception. The symptoms of someone with mosaic trisomy 21 may vary from those of someone with complete trisomy 21 or translocation trisomy 21, depending on how many cells have the extra chromosome.
- **Translocation trisomy 21**. In this type of chromosomal change, only part of an extra copy of chromosome 21 is in the cells. The extra part of the chromosome gets "stuck" to another chromosome and gets transmitted into other cells as the cells divide. This type of change causes about 4% of Down syndrome cases. There are no distinct cognitive or medical differences between people with translocation trisomy 21 and those with complete trisomy 21.

  Sometimes, a parent who does not have Down syndrome may carry a translocation in chromosome 21 that can be passed on to children and cause Down syndrome. Studying the parents' chromosomes can reveal whether this is the cause of the syndrome. A genetic counselor can assist families affected by translocation trisomy 21 in understanding the risk of Down syndrome in future pregnancies.

How do health care providers diagnose Down syndrome?

Health care providers can check for Down syndrome during pregnancy or after a child is born. There are two types of tests for Down syndrome during pregnancy:

- A prenatal screening test. This test can show an increased likelihood that a fetus has Down syndrome, but it cannot determine Down syndrome is definitely present. If a screening test shows an increased likelihood, a diagnostic test can be ordered.
- A prenatal diagnostic test. This test can determine with certainty that Down syndrome is present. Diagnostic tests carry a slightly greater risk to the fetus than do screening tests.
- The American Congress of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women be offered a Down syndrome screening test.

Prenatal Screening for Down Syndrome

There are several options for Down syndrome prenatal screening. These include:

- A blood test and an ultrasound test during the first trimester of pregnancy. This is the most accepted approach for screening during the first trimester. A blood test enables a health care provider to check for "markers," such as certain proteins, in the mother's blood that suggest an increased likelihood of Down syndrome.[2] Then the health care provider does an ultrasound test, which uses high-frequency sound waves to create images. An ultrasound can detect fluid at the back of a fetus's neck, which sometimes indicates Down syndrome. The ultrasound test is called measurement of nuchal translucency. During the first trimester, this combined method results in more effective or comparable detection rates than methods used during the second trimester.
- A blood test during the second trimester of pregnancy. As in the first trimester, a blood test enables a health care provider to check for markers in the mother's blood. A triple screen looks for levels of three different markers; a quadruple screen looks for levels of four different markers.
- A combined test (sometimes called an integrated test). This approach uses both a blood test and an ultrasound during the first trimester as well as a second-trimester blood test. Health care providers then combine all these results to produce one Down syndrome risk rating.

If a woman is pregnant with twins or triplets, a blood test will not be as reliable because the substances from a Down syndrome fetus may be harder to detect.

Prenatal Diagnostic Testing for Down Syndrome

If a screening test suggests the likelihood of Down syndrome, a diagnostic test can be performed. ACOG recommends that pregnant women of all ages be given the option of skipping the screening test and getting a diagnostic test first. Until recently, only women over age 35 and other at-risk women were offered this option because diagnostic tests carry a slight risk of miscarriage.[1] Before having diagnostic testing, a pregnant woman and her family may want to meet with a genetic counselor to discuss their family history and the risks and benefits of testing in their specific situation.

Diagnostic testing for Down syndrome involves removing a sample of genetic material. After it is removed, the sample is checked for extra material from chromosome 21, which may indicate that a fetus has Down syndrome. Parents usually get the results of the test a week or two later. The following procedures are used to extract samples.

- Amniocentesis (pronounced *am-nee-oh-sen-TEE-sis*). A health care provider takes a sample of amniotic (pronounced *am-nee-OT-ik*) fluid, which is then tested for the extra chromosome. This test cannot be done until week 14 to 18 of the pregnancy.
- Chorionic villus (pronounced *KOHR-ee-on-ik VIL-uhs*) sampling (CVS). A health care provider takes a sample of cells from a part of the placenta (pronounced *pluh-SEN-tuh*), which is the organ that connects a woman and her fetus, and then tests the sample for the extra chromosome. This test is done between weeks 9 and 11 of pregnancy.
- Percutaneous (pronounced *pur-kyoo-TEY-nee-uhs*) umbilical blood sampling (PUBS). A health care provider takes a sample of fetal blood in the umbilical cord through the uterus. The blood is then tested for the extra chromosome. PUBS is the most accurate diagnostic method and can confirm the results of CVS or amniocentesis. However, PUBS cannot be performed until later in the pregnancy, during the 18th to 22nd week.

Prenatal diagnostic testing does involve some risk to the mother and fetus, including risk of miscarriage that ranges from less than 1% to 2%. If you and your family are considering prenatal diagnostic testing for Down syndrome, discuss all the risks and benefits with your health care provider.

Chromosomal Testing of Maternal Blood

A pregnant woman who is at risk for having an infant with Down syndrome also can have a chromosomal test using her blood. A mother's blood carries DNA from the fetus, which may show extra chromosome 21 material. A more invasive test then would usually confirm the blood test.

Testing and In Vitro Fertilization

Another approach to diagnosis is used in conjunction with in vitro fertilization. Preimplantation genetic diagnosis (PGD) allows clinicians to detect chromosome imbalances or other genetic conditions in a fertilized egg before it is implanted into the uterus.

This technique is useful mostly for couples who are at risk of passing on a variety of genetic conditions, including X-linked disorders, as well as couples who have suffered repeated spontaneous pregnancy losses, sub-fertile couples, or those at risk for single-gene disorders.

Those interested in PGD should have genetic counseling and should consider close monitoring and additional testing during their pregnancies, given some increased risk of chromosomal abnormalities arising secondary to the in vitro fertilization process.

Diagnosis of Down Syndrome After Birth

A diagnosis of Down syndrome after birth is often based initially on physical signs of the syndrome.

But because individuals with Down syndrome may not have these symptoms, and because many of these symptoms are common in the general population, the health care provider will take a sample of the baby's blood to confirm the diagnosis. The blood sample is analyzed to determine the number of the baby's chromosomes.

How many people are affected by or at risk for Down syndrome?

According to the Centers for Disease Control and Prevention, approximately 6,000 babies are born in the United States each year with Down syndrome, or approximately 1 out of every 691 live births.

Down syndrome is the most frequent chromosomal cause of mild to moderate intellectual disability, and it occurs in all ethnic and economic groups. Currently, more than 400,000 people are living with Down syndrome in the United States, according to the National Down Syndrome Society.

Researchers know some, but not all, of the risk factors for Down syndrome. For example, parents who have a child with Down syndrome or another chromosomal disorder, or who have a chromosomal disorder themselves, are more likely to have a child with Down syndrome.

In the United States, demographic factors also affect the risk for a child to be born with Down syndrome. These factors include geographic region, maternal education, marital status, and Hispanic ethnicity.

Maternal Age and Risk for Down Syndrome

Because the likelihood that an egg will contain an extra copy of chromosome 21 increases significantly as a woman ages, older women are much more likely than younger women to give birth to an infant with Down syndrome. Although women older than 35 years of age make up less than 15% of all births in the United States each year, about 40% of babies with Down syndrome are born to women in this age group.

This likelihood increases as age increases. Following are the rates of Down syndrome for select ages:

- At age 25, the likelihood is 1 in 1,300
- At age 30, the likelihood is 1 in 900
- At age 35, the likelihood is 1 in 350
- At age 42, the likelihood is 1 in 55
- At age 49, the likelihood is 1 in 25

What are common symptoms of Down syndrome?

The symptoms of Down syndrome vary from person to person, and people with Down syndrome may have different problems at different times of their lives.

Physical Symptoms

Common physical signs of Down syndrome include:

- Decreased or poor muscle tone
- Short neck, with excess skin at the back of the neck
- Flattened facial profile and nose
- Small head, ears, and mouth
- Upward slanting eyes, often with a skin fold that comes out from the upper eyelid and covers the inner corner of the eye
- White spots on the colored part of the eye (called Brushfield spots)
- Wide, short hands with short fingers
- A single, deep, crease across the palm of the hand
- A deep groove between the first and second toes
- Curvature of the pinky finger

In addition, physical development in children with Down syndrome is often slower than development of children without Down syndrome. For example, because of poor muscle tone, a child with Down syndrome may be slow to learn to turn over, sit, stand, and walk. Despite these delays, children with Down syndrome can learn to participate in physical exercise activities like other children. It may take children with Down syndrome longer than other children to reach developmental milestones, but they will eventually meet many of these milestones.

Intellectual and Developmental Symptoms

Cognitive impairment, problems with thinking and learning, is common in people with Down syndrome and usually ranges from mild to moderate. Only rarely is Down syndrome associated with severe cognitive impairment.

Other common cognitive and behavioral problems may include:

- Short attention span
- Poor judgment
- Impulsive behavior
- Slow learning
- Delayed language and speech development

Most children with Down syndrome develop the communication skills they need, although it might take longer for them to do so compared with other children. Early, ongoing speech and language interventions to encourage expressive language and improve speech are particularly helpful.

Parents and families of children with Down syndrome can connect with other families and people with Down syndrome from around the world to learn more and share information. The NICHD-led DS-Connect® is a safe and secure registry to help families and researchers identify similarities and differences in the physical and developmental symptoms and milestones of people with Down syndrome and guide future research.

People with Down syndrome are at increased risk for a range of other health conditions, including autism spectrum disorders, problems with hormones and glands, hearing loss, vision problems, and heart abnormalities.

National Down Syndrome Congress informational brochure

National Down Syndrome Society's About Down Syndrome Brochure

What is Down syndrome?

Down syndrome describes a set of cognitive and physical symptoms that result from an extra copy or part of a copy of chromosome 21.

Chromosomes carry the genes that tell the body to develop in certain ways and to perform certain functions. Most cells of the human body contain 23 pairs of chromosomes—one set of chromosomes from each parent—for a total of 46 chromosomes. People with Down syndrome have either a full or partial extra copy of chromosome 21, for a total of 47 chromosomes. (The syndrome is sometimes called 47,XX,+21 or 47,XY,+21 to indicate the extra chromosome 21.)

The extra chromosome disrupts the normal course of development and results in the physical features and intellectual and developmental disabilities associated with the syndrome.[1]

The degree of intellectual disability in people with Down syndrome varies but is usually mild to moderate. Generally, children with Down syndrome reach key developmental milestones later than other children. People with the syndrome also are more likely to be born with heart abnormalities, and they are at increased risk for developing hearing and vision problems, Alzheimer disease, and other conditions. However, with appropriate support and treatment, many people with Down syndrome lead happy, productive lives. In recent decades, life expectancy for people with Down syndrome has increased dramatically, from 25 years in 1983 to 60 years today.

Down syndrome is named after John Langdon Down, the first physician to describe the syndrome systematically.

What conditions or disorders are commonly associated with Down syndrome?

In addition to intellectual and developmental disabilities, children with Down syndrome are at an increased risk for certain health problems. However, each individual with Down syndrome is different, and not every person will have serious health problems. Many of these associated conditions can be treated with medication, surgery, or other interventions.

Some of the conditions that occur more often among children with Down syndrome include:

- **Heart defects**. Almost one-half of babies with Down syndrome have congenital heart disease (CHD), the most common type of birth defect. CHD can lead to high blood pressure in the lungs, an inability of the heart to effectively and efficiently pump blood, and cyanosis (blue-tinted skin caused by reduced oxygen in the blood). For this reason, the American Academy of Pediatrics (AAP) Committee on Genetics recommends infants with Down syndrome receive an echocardiogram (a sound "picture" of the heart) and an evaluation from a pediatric cardiologist. Sometimes, the heart defect can be detected before birth, but testing after birth is more accurate. Some heart defects are minor and may be treated with medication, but others require immediate surgery.
- **Vision problems**. More than 60% of children with Down syndrome have vision problems, including cataracts (clouding of the eye lens) that may be present at birth. The risk of cataract increases with age. Other eye problems that are more likely in children with Down syndrome are near-sightedness, "crossed" eyes, and rapid, involuntary eye movements. Glasses, surgery, or other treatments usually improve vision. The AAP recommends that infants with Down syndrome be examined by a pediatric eye specialist during the newborn period, and then have vision exams regularly as recommended.
- **Hearing loss**. About 70% to 75% of children with Down syndrome have some hearing loss, sometimes because of problems with ear structures. The AAP recommends that babies with Down syndrome be screened for hearing loss at birth and have regular follow-up hearing exams. Many inherited hearing problems can be corrected. Children with Down syndrome also tend to get a lot of ear infections. These should be treated quickly to prevent possible hearing loss.
- **Infections**. People with Down syndrome are 12 times more likely to die from untreated and unmonitored infections than other people. Down syndrome often causes problems in the immune system that can make it difficult for the body to fight off infections, so even seemingly minor infections should be treated quickly and monitored continuously. Caregivers also should make sure that children with Down syndrome receive all recommended immunizations to help prevent certain infections. Infants with Down syndrome have a 62-fold higher rate of pneumonia, especially in the first year after birth, than do infants without Down syndrome, for example.
- **Hypothyroidism**. The thyroid is a gland that makes hormones the body uses to regulate things such as temperature and energy. Hypothyroidism, when the thyroid makes little or no thyroid hormone, occurs more often in children with Down syndrome than in children without Down syndrome. Taking thyroid hormone by mouth, throughout life, can successfully treat the condition. A child may have thyroid problems at birth or may develop them later, so health care providers recommend a thyroid examination at birth, at 6 months, and annually throughout life. Routine newborn screening may detect hypothyroidism at birth. However, some state newborn screening programs only screen for hypothyroidism one way, by measuring free thyroxine (T4) in the blood. Because many infants with Down syndrome have normal T4, they should be screened for levels of thyroid stimulating hormone (TSH) in these states as well.

- **Blood disorders**. Children with Down syndrome are 10 to 15 times more likely than other children to develop leukemia (pronounced *loo-KEE-mee-uh*), which is cancer of the white blood cells. Children with leukemia should receive appropriate cancer treatment, which may include chemotherapy. Those with Down syndrome are also more likely to have anemia (low iron in the blood) and polycythemia (high red blood cell levels), among other blood disorders. These conditions may require additional treatment and monitoring.
- **Hypotonia (poor muscle tone)**. Poor muscle tone and low strength contribute to the delays in rolling over, sitting up, crawling, and walking that are common in children with Down syndrome. Despite these delays, children with Down syndrome can learn to participate in physical activities like other children. Poor muscle tone, combined with a tendency for the tongue to stick out, can also make it difficult for an infant with Down syndrome to feed properly, regardless of whether they are breastfed or fed from a bottle. Infants may need nutritional supplements to ensure they are getting all the nutrients they need. Parents can work with breastfeeding experts and pediatric nutritionists to ensure proper nutrition. In some cases, the weak muscles can cause problems along the digestive tract, leading to various digestive problems, from difficulty swallowing to constipation. Families may need to work with a gastroenterologist to overcome these problems.
- **Problems with the upper part of the spine**. One or two of every ten children with Down syndrome has misshapen bones in the upper part of the spine, underneath the base of the skull. These misshaped bones can press on the spinal cord and increase the risk for injury. It is important to determine if these spinal problems (called atlantoaxial [pronounced *at-lan-to-AK-se-al*] instability) are present before the child has any surgery because certain movements required for anesthesia or surgery could cause permanent injury. In addition, some sports have an increased risk of spinal injury, so possible precautions should be discussed with a child's health care provider.
- **Disrupted sleep patterns and sleep disorders**. Many children with Down syndrome have disrupted sleep patterns and often have obstructive sleep apnea, which causes significant pauses in breathing during sleep. A child's health care provider may recommend a sleep study in a special sleep lab to detect problems and determine possible solutions. It might be necessary to remove the tonsils or to use a continuous positive airway pressure device to create airflow during sleep.
- **Gum disease and dental problems**. Children with Down syndrome may develop teeth more slowly than other children, develop teeth in a different order, develop fewer teeth, or have misaligned teeth compared to children who do not have Down syndrome. Gum disease (periodontal disease), a more serious health issue, may develop for a number of reasons, including poor oral hygiene. Health care providers recommend visiting the dentist within 6 months of the appearance of the child's first tooth or by the time the child is 1 year old.
- **Epilepsy**. Children with Down syndrome are more likely to have epilepsy, a condition characterized by seizures, than those without Down syndrome. The risk for epilepsy increases with age, but seizures usually occur either during the first 2 years of life or after the third decade of life. Almost one-half of people with Down syndrome who are older than age 50 have epilepsy. Seizures can usually be treated and controlled well with medication.
- **Digestive problems**. Digestive problems range from structural defects in the digestive system or its organs, to problems digesting certain types of foods or food ingredients. Treatments for these problems vary based on the specific problem. Some structural defects require surgery. Some people with Down syndrome have to eat a special diet throughout their lifetime.
- **Celiac disease**. People with celiac disease experience intestinal problems when they eat gluten, a protein in wheat, barley, and rye. Because children with Down syndrome are more likely to have celiac disease, health care providers recommend testing for it at age 2 or even younger if the child is having celiac symptoms.

- **Mental health and emotional problems**. Children with Down syndrome may experience behavioral and emotional problems, including anxiety, depression, and Attention Deficit Hyperactivity Disorder. They might also display repetitive movements, aggression, autism, psychosis, or social withdrawal. Although they are not more likely to experience these problems, they are more likely to have difficulty coping with the problems in positive ways, especially during adolescence. Treatments may include working with a behavioral specialist and taking medications.

The conditions listed above are ones that are commonly found in children with Down syndrome.

What are common treatments for Down syndrome?

There is no single, standard treatment for Down syndrome. Treatments are based on each individual's physical and intellectual needs as well as his or her personal strengths and limitations. People with Down syndrome can receive proper care while living at home and in the community.

A child with Down syndrome likely will receive care from a team of health professionals, including, but not limited to, physicians, special educators, speech therapists, occupational therapists, physical therapists, and social workers. All professionals who interact with children with Down syndrome should provide stimulation and encouragement.

People with Down syndrome are at a greater risk for a number of health problems and conditions than are those who do not have Down syndrome. Many of these associated conditions may require immediate care right after birth, occasional treatment throughout childhood and adolescence, or long-term treatments throughout life. For example, an infant with Down syndrome may need surgery a few days after birth to correct a heart defect; or a person with Down syndrome may have digestive problems that require a lifelong special diet.

Children, teens, and adults with Down syndrome also need the same regular medical care as those without the condition, from well-baby visits and routine vaccinations as infants to reproductive counseling and cardiovascular care later in life. Like other people, they also benefit from regular physical activity and social activities.

Early Intervention and Educational Therapy

“Early intervention” refers to a range of specialized programs and resources that professionals provide to very young children with Down syndrome and their families. These professionals may include special educators, speech therapists, occupational therapists, physical therapists, and social workers.

Research indicates that early intervention improves outcomes for children with Down syndrome. This assistance can begin shortly after birth and often continues until a child reaches age 3. After that age, most children receive interventions and treatment through their local school district.

Most children with Down syndrome are eligible for free, appropriate public education under federal law. Public Law 105-17 (2004): The Individuals with Disabilities Education Act (IDEA) makes it possible for children with disabilities to get free educational services and devices to help them learn as much as they can. Each child is entitled to these services from birth through the end of high school, or until age 21, whichever comes first. Most early intervention programs fall under this legislation.

The National Early Childhood Technical Assistance Center, run by the U.S. Department of Education, provides information and resources for parents and families looking for early intervention programs. Visit http://www.nectac.org for more information. Additional early intervention resources are available athttp://day2dayparenting.com/category/child-development-2/special-needs-diagnoses/, and at http://www.familyvoices.org.

The law also states that each child must be taught in the least restrictive environment that is appropriate. This statement does not mean that each child will be placed in a regular classroom. Instead, educators will work to provide an environment that best fits the child's needs and skills.

The following information may be helpful for those considering educational assistance programs for a child with Down syndrome:

- The child must have certain cognitive or learning deficits to be eligible for free special education programs. Parents can contact a local school principal or special education coordinator to learn how to have a child examined to see if he or she qualifies for services under the IDEA.
- If a child qualifies for special services, a team of people will work together to design an Individualized Educational Plan (IEP) for the child. The team may include parents or caregivers, teachers, a school psychologist, and other specialists in child development or education. The IEP includes specific learning goals for that child, based on his or her needs and capabilities. The team also decides how best to carry out the IEP.
- Children with Down syndrome may attend a school for children with special needs. Parents may have a choice between a school where most of the children do not have disabilities and one for children with special needs. Educators and health care providers can help families with the decision about what environment is best. Integration into a regular school has become much more common in recent decades, and IDEA requires that public schools work to maximize a child's access to typical learning experiences and interactions.

The U.S. Department of Education funds the Parent Center Network, which provides resources, contacts, and assistance for parents and families trying to navigate special education programs. Visit http://www.parentcenterhub.org/ptacs/ for more information.

Treatment Therapies

A variety of therapies can be used in early intervention programs and throughout a person's life to promote the greatest possible development, independence, and productivity. Some of these therapies are listed below.

- **Physical therapy** includes activities and exercises that help build motor skills, increase muscle strength, and improve posture and balance. Physical therapy is important, especially early in a child's life, because physical abilities lay the foundation for other skills. The ability to turn over, crawl, and reach helps infants learn about the world around them and how to interact with it.
- A physical therapist also can help a child with Down syndrome compensate for physical challenges, such as low muscle tone, in ways that avoid long-term problems. For example, a physical therapist might help a child establish an efficient walking pattern, rather than one that might lead to foot pain.

- **Speech-language therapy** can help children with Down syndrome improve their communication skills and use language more effectively.
    - Children with Down syndrome often learn to speak later than their peers. A speech-language therapist can help them develop the early skills necessary for communication, such as imitating sounds. The therapist also may help an infant breastfeed because breastfeeding can strengthen muscles that are used for speech.
    - In many cases, children with Down syndrome understand language and want to communicate before they can speak. A speech-language therapist can help a child use alternate means of communication, such as sign language and pictures, until he or she learns to speak.
    - Learning to communicate is an ongoing process, so a person with Down syndrome also may benefit from speech and language therapy in school as well as later in life. The therapist may

help with conversation skills, pronunciation skills, understanding what is read (called comprehension), and learning and remembering words.

- **Occupational therapy** helps find ways to adjust everyday tasks and conditions to match a person's needs and abilities.
    - This type of therapy teaches self-care skills such as eating, getting dressed, writing, and using a computer.
    - An occupational therapist might offer special tools that can help improve everyday functioning, such as a pencil that is easier to grip.
    - At the high school level, an occupational therapist could help teenagers identify jobs, careers, or skills that match their interests and strengths.
- **Emotional and behavioral therapies** work to find useful responses to both desirable and undesirable behaviors. Children with Down syndrome may become frustrated because of difficulty communicating, may develop compulsive behaviors, and may have Attention Deficit Hyperactivity Disorder and other mental health issues. These types of therapists try to understand why a child is acting out, create ways and strategies for avoiding or preventing these situations from occurring, and teach better or more positive ways to respond to situations.
    - A psychologist, counselor, or other mental health professional can help a child deal with emotions and build coping and interpersonal skills.
    - The changes in hormone levels that adolescents experience during puberty can cause them to become more aggressive. Behavioral therapists can help teenagers recognize their intense emotions and teach them healthy ways to reach a feeling of calmness.
    - Parents may also benefit from guidance on how to help a child with Down syndrome manage day-to-day challenges and reach his or her full potential.

Drugs and Supplements

Some people with Down syndrome take amino acid supplements or drugs that affect their brain activity. However, many of the recent clinical trials of these treatments were poorly controlled and revealed adverse effects from these treatments. Since then, newer psychoactive drugs that are much more specific have been developed. No controlled clinical studies of these medications for Down syndrome have demonstrated their safety and efficacy, however, many studies of drugs to treat symptoms of dementia in Down syndrome have included only a few participants. The results of these studies have not shown clear benefits of these drugs, either. Similarly, studies of antioxidants for dementia in Down syndrome have shown that these supplements are safe, but not effective.

Assistive Devices

More and more often, interventions for children with Down syndrome involve assistive devices—any type of material, equipment, tool, or technology that enhances learning or makes tasks easier to complete. Examples include amplification devices for hearing problems, bands that help with movement, special pencils to make writing easier, touchscreen computers, and computers with large-letter keyboards.