



## Down syndrome

Down syndrome is a chromosomal condition that is associated with intellectual disability, a characteristic facial appearance, and weak muscle tone (hypotonia) in infancy. All affected individuals experience cognitive delays, but the intellectual disability is usually mild to moderate.

People with Down syndrome may have a variety of birth defects. About half of all affected children are born with a heart defect. Digestive abnormalities, such as a blockage of the intestine, are less common.

Individuals with Down syndrome have an increased risk of developing several medical conditions. These include gastroesophageal reflux, which is a backflow of acidic stomach contents into the esophagus, and celiac disease, which is an intolerance of a wheat protein called gluten. About 15 percent of people with Down syndrome have an underactive thyroid gland (hypothyroidism). The thyroid gland is a butterfly-shaped organ in the lower neck that produces hormones. Individuals with Down syndrome also have an increased risk of hearing and vision problems. Additionally, a small percentage of children with Down syndrome develop cancer of blood-forming cells (leukemia).

Delayed development and behavioral problems are often reported in children with Down syndrome. Affected individuals' speech and language develop later and more slowly than in children without Down syndrome, and affected individuals' speech may be more difficult to understand. Behavioral issues can include attention problems, obsessive/compulsive behavior, and stubbornness or tantrums. A small percentage of people with Down syndrome are also diagnosed with developmental conditions called autism spectrum disorders, which affect communication and social interaction.

People with Down syndrome often experience a gradual decline in thinking ability (cognition) as they age, usually starting around age 50. Down syndrome is also associated with an increased risk of developing Alzheimer disease, a brain disorder that results in a gradual loss of memory, judgment, and ability to function. Approximately half of adults with Down syndrome develop Alzheimer disease. Although Alzheimer disease is usually a disorder that occurs in older adults, people with Down syndrome usually develop this condition in their fifties or sixties.

### Frequency

Down syndrome occurs in about 1 in 800 newborns. About 5,300 babies with Down syndrome are born in the United States each year, and approximately 200,000 people in this country have the condition. Although women of any age can have a child with Down syndrome, the chance of having a child with this condition increases as a woman gets older.

## **Genetic Changes**

Most cases of Down syndrome result from trisomy 21, which means each cell in the body has three copies of chromosome 21 instead of the usual two copies.

Less commonly, Down syndrome occurs when part of chromosome 21 becomes attached (translocated) to another chromosome during the formation of reproductive cells (eggs and sperm) in a parent or very early in fetal development. Affected people have two normal copies of chromosome 21 plus extra material from chromosome 21 attached to another chromosome, resulting in three copies of genetic material from chromosome 21. Affected individuals with this genetic change are said to have translocation Down syndrome.

A very small percentage of people with Down syndrome have an extra copy of chromosome 21 in only some of the body's cells. In these people, the condition is called mosaic Down syndrome.

Researchers believe that having extra copies of genes on chromosome 21 disrupts the course of normal development, causing the characteristic features of Down syndrome and the increased risk of health problems associated with this condition.

## **Inheritance Pattern**

Most cases of Down syndrome are not inherited. When the condition is caused by trisomy 21, the chromosomal abnormality occurs as a random event during the formation of reproductive cells in a parent. The abnormality usually occurs in egg cells, but it occasionally occurs in sperm cells. An error in cell division called nondisjunction results in a reproductive cell with an abnormal number of chromosomes. For example, an egg or sperm cell may gain an extra copy of chromosome 21. If one of these atypical reproductive cells contributes to the genetic makeup of a child, the child will have an extra chromosome 21 in each of the body's cells.

People with translocation Down syndrome can inherit the condition from an unaffected parent. The parent carries a rearrangement of genetic material between chromosome 21 and another chromosome. This rearrangement is called a balanced translocation. No genetic material is gained or lost in a balanced translocation, so these chromosomal changes usually do not cause any health problems. However, as this translocation is passed to the next generation, it can become unbalanced. People who inherit an unbalanced translocation involving chromosome 21 may have extra genetic material from chromosome 21, which causes Down syndrome.

Like trisomy 21, mosaic Down syndrome is not inherited. It occurs as a random event during cell division early in fetal development. As a result, some of the body's cells have the usual two copies of chromosome 21, and other cells have three copies of this chromosome.

## Other Names for This Condition

- 47,XX,+21
- 47,XY,+21
- Down's syndrome
- trisomy 21
- trisomy G

## Diagnosis & Management

### Genetic Testing

- Genetic Testing Registry: Complete trisomy 21 syndrome  
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C0013080/>

### Other Diagnosis and Management Resources

- National Down Syndrome Congress: Health Care & Medical Resources  
<https://www.ndsccenter.org/programs-resources/health-care/>
- National Down Syndrome Congress: Speech and Language  
<https://www.ndsccenter.org/programs-resources/speech-and-language/>
- National Down Syndrome Society: Health Care & Research  
[https://www.ndss.org/rescat\\_lifespan/tax/health-care-research/](https://www.ndss.org/rescat_lifespan/tax/health-care-research/)
- National Down Syndrome Society: Therapies & Development  
<https://www.ndss.org/resources/therapies-development/>

### General Information from MedlinePlus

- Diagnostic Tests  
<https://medlineplus.gov/diagnostictests.html>
- Drug Therapy  
<https://medlineplus.gov/drugtherapy.html>
- Genetic Counseling  
<https://medlineplus.gov/geneticcounseling.html>
- Palliative Care  
<https://medlineplus.gov/palliativecare.html>
- Surgery and Rehabilitation  
<https://medlineplus.gov/surgeryandrehabilitation.html>

## **Additional Information & Resources**

### MedlinePlus

- Encyclopedia: Down Syndrome  
<https://medlineplus.gov/ency/article/000997.htm>
- Health Topic: Congenital Heart Defects  
<https://medlineplus.gov/congenitalheartdefects.html>
- Health Topic: Down Syndrome  
<https://medlineplus.gov/downsyndrome.html>

### Genetic and Rare Diseases Information Center

- Down syndrome  
<https://rarediseases.info.nih.gov/diseases/10247/down-syndrome>

### Additional NIH Resources

- Eunice Kennedy Shriver National Institute of Child Health and Human Development  
<https://www.nichd.nih.gov/health/topics/downsyndrome>
- GeneEd  
[https://geneed.nlm.nih.gov/topic\\_subtopic.php?tid=142&sid=147](https://geneed.nlm.nih.gov/topic_subtopic.php?tid=142&sid=147)
- National Human Genome Research Institute  
<https://www.genome.gov/19517824/>
- National Institute of Diabetes and Digestive and Kidney Diseases: Hypothyroidism  
<https://www.niddk.nih.gov/health-information/endocrine-diseases/hypothyroidism>

### Educational Resources

- Boston Children's Hospital  
<http://www.childrenshospital.org/conditions-and-treatments/conditions/d/down-syndrome>
- Centre for Genetics Education (Australia)  
<http://www.genetics.edu.au/publications-and-resources/facts-sheets/fact-sheet-36-trisomy-21-down-syndrome>
- cK-12: Nondisjunction (Trisomy 21)  
[https://www.ck12.org/biology/Gametogenesis/enrichment/Nondisjunction/?referrer=concept\\_details](https://www.ck12.org/biology/Gametogenesis/enrichment/Nondisjunction/?referrer=concept_details)
- Disease InfoSearch: Down Syndrome  
<http://www.diseaseinfosearch.org/Down+Syndrome/2327>
- Down Syndrome: Health Issues (Len Leshin, M.D., F.A.A.P.)  
<http://www.ds-health.com/>

- Genetic Science Learning Center, University of Utah  
<http://learn.genetics.utah.edu/content/disorders/extraormissing/>
- Kennedy Krieger Institute  
<https://www.kennedykrieger.org/patient-care/diagnoses-disorders/down-syndrome>
- KidsHealth from the Nemours Foundation  
<http://kidshealth.org/en/kids/down-syndrome.html>
- MalaCards: down syndrome  
[http://www.malacards.org/card/down\\_syndrome](http://www.malacards.org/card/down_syndrome)
- Merck Manual Consumer Version  
<https://www.merckmanuals.com/home/children-s-health-issues/chromosome-and-gene-abnormalities/down-syndrome-trisomy-21>
- Orphanet: Down syndrome  
[https://www.orpha.net/consor/cgi-bin/OC\\_Exp.php?Lng=EN&Expert=870](https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=870)
- Your Genes Your Health from Cold Spring Harbor Laboratory  
<http://www.ygyh.org/ds/whatisit.htm>
- Your Genome from Wellcome Genome Campus  
<https://www.yourgenome.org/facts/what-is-downs-syndrome>

#### Patient Support and Advocacy Resources

- Chromosome Disorder Outreach  
<https://chromodisorder.org/>
- LuMind Research Down Syndrome Foundation  
<https://www.lumindrds.org/>
- LuMind Research Down Syndrome Foundation  
<https://www.lumindrds.org/>
- National Down Syndrome Congress  
<https://www.ndsccenter.org/>
- National Down Syndrome Society  
<http://www.ndss.org>
- Resource list from the University of Kansas Medical Center  
[http://www.kumc.edu/gec/support/down\\_syn.html](http://www.kumc.edu/gec/support/down_syn.html)

#### ClinicalTrials.gov

- ClinicalTrials.gov  
<https://clinicaltrials.gov/ct2/results?cond=%22down+syndrome%22>

## Scientific Articles on PubMed

- PubMed  
<https://www.ncbi.nlm.nih.gov/pubmed?term=%28Down+Syndrome%5BMAJR%5D%29+AND+%28Down+syndrome%5BTI%5D%29+AND+review%5Bpt%5D+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1080+days%22%5Bdp%5D>

## OMIM

- DOWN SYNDROME  
<http://omim.org/entry/190685>

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