

This fact sheet describes the chromosome condition Trisomy 21 and includes the symptoms, cause and any treatment or testing which is available.

### In summary

- Trisomy 21 is also known as Down syndrome and is the most common chromosome condition that babies are born with
- People with Down syndrome usually have distinctive facial features, some intellectual disability and heart or digestive tract problems
- Down syndrome is caused by having an extra copy of chromosome number 21.

### WHAT IS DOWN SYNDROME?

Down syndrome is also known as trisomy 21. It is named after the doctor, John Langdon Down, who in 1866 described a number of his patients with similar characteristics such as a broad, flat face, a thick tongue, a small nose and variable degrees of intellectual disability.

Down syndrome is well understood these days and although many different symptoms and features have been described, not everyone with Down syndrome will have all of them. The number of symptoms and the severity can vary from one person to the next.

At birth, many babies with Down syndrome will have one or more of the following features:

- Low muscle tone (a floppy baby)
- A face that appears flatter with eyes slanting upward

- Small ears and a wider neck than usual
- A crease across the palm of the hand and a gap between the first and second toes ('sandal-gap' sign)
- Health problems including those which affect the heart, digestive system and general development.

While intellectual disability is a feature of Down syndrome, most children are able to learn and develop at their own individual pace. Early intervention programs are very effective in maximising the learning potential of children with Down syndrome.

### WHAT CAUSES DOWN SYNDROME?

About 1 in every 1000 babies in Australia is born with Down syndrome and it affects people of all ethnic backgrounds.

In each human cell, except the egg and sperm cells, there are 46 chromosomes. Chromosomes are found in pairs and each pair varies in size.

Thus there are 23 pairs of chromosomes, one of each pair being inherited from each parent.

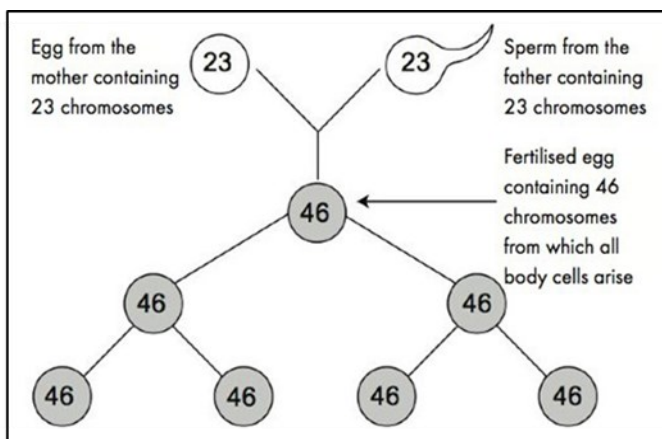
- There are 22 numbered chromosomes from the largest to the smallest: i.e. 1-22. These are called autosomes
- There are also two sex chromosomes, called X and Y.

In females, cells in the body have 46 chromosomes (44 autosomes plus two copies of the X chromosome). They are said to have a 46,XX karyotype. Eggs (female reproductive cells) are different as they only contain half of the chromosomes (23 made up of 22 numbered chromosomes and an X chromosome).

In males, cells in the body have 46 chromosomes (44 autosomes plus an X and a Y chromosome). They are said to have a 46,XY karyotype. Sperm (male reproductive cells) are different as they only contain half of the chromosomes (23 made up of 22 numbered chromosomes and an X chromosome or a Y chromosome).

When egg and sperm cells are formed, the chromosome pairs separate so that there is only one of each pair in these cells i.e. 23 chromosomes instead of 46. A baby is conceived when the egg from the mother and the sperm from the father come together.

The baby would then have two copies of each chromosome (46 chromosomes in total) just like the parents. One copy of each chromosome would have come from the mother and one copy from the father (See *Figure 36.1*).



*Figure 36.1: At conception the sperm and egg combine*

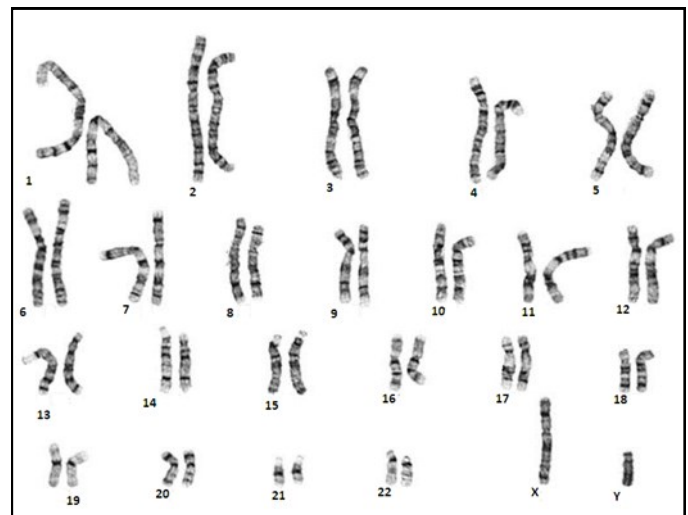
Figure 36.2 shows a banded chromosome set from a male where each chromosome has been numbered from the largest (chromosome number 1) to the smallest (chromosome number 22) and arranged in pairs in order of size.

We know these chromosomes are from a male because of the X and a Y.

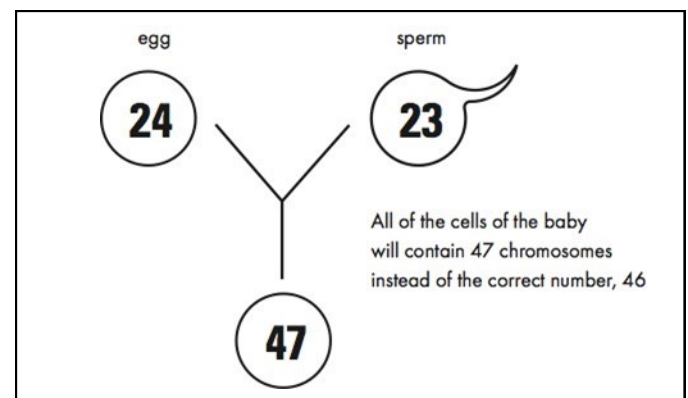
Sometimes, when the egg and sperm are forming, a mistake can occur so that the chromosome pairs do not separate in the usual way. The result is an egg or sperm cell that has only 22 chromosomes while others have 24 chromosomes.

If an egg or sperm carrying 24 chromosomes combines with an egg or sperm carrying the usual 23 chromosomes, the result would be an individual with cells in which there are 47 chromosomes instead of the usual 46 (See *Figure 36.3*).

- There would be three copies of a particular chromosome in the cells rather than two. This is called **trisomy**.



*Figure 36.2: Chromosome picture (karyotype) from a male 46,XY.*

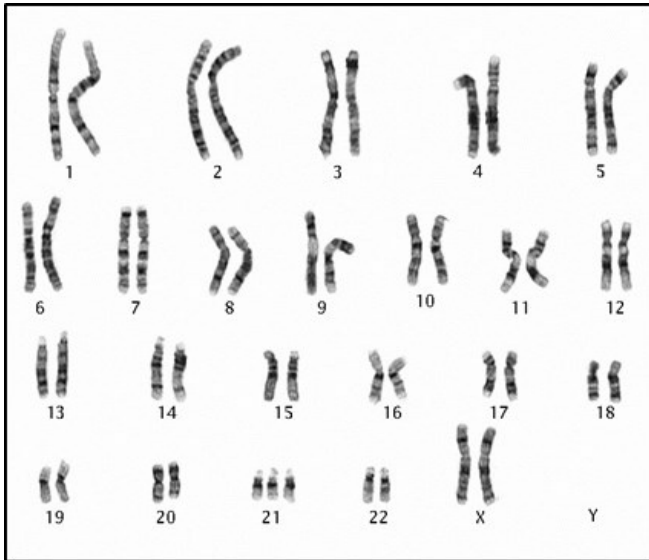


*Figure 36.3: When the egg has 24 chromosomes, and the sperm has the usual 23, the baby's cells will contain 47 chromosomes instead of 46.*

The chromosome pattern in people with Down syndrome includes an extra copy of chromosome number 21. This is a small chromosome but even so, still causes an imbalance and is the reason why there are differences in people with 3 copies of chromosome 21 material (as in Down syndrome) and those with the usual 2 copies of chromosome 21.

The presence of the extra copy of chromosome 21 causes the intellectual and physical characteristics of Down syndrome. Individuals with this condition usually have three copies of chromosome number 21, i.e. 47 chromosomes in their cells instead of 46. **Trisomy** means *three bodies*.

Figure 36.4 is a picture (karyotype) of the chromosomes from a female with trisomy 21.



**Figure 36.4:** Chromosome picture (karyotype) from a female with trisomy 21. In this cell, there are 47 chromosomes including three copies of chromosome 21 instead of the usual two.

**Some people have Down syndrome as a result of a Robertsonian translocation.**

Down syndrome due to a Robertsonian translocation occurs when chromosome 21 material is *glued* or *translocated* on to another chromosome (See Figure 36.5).



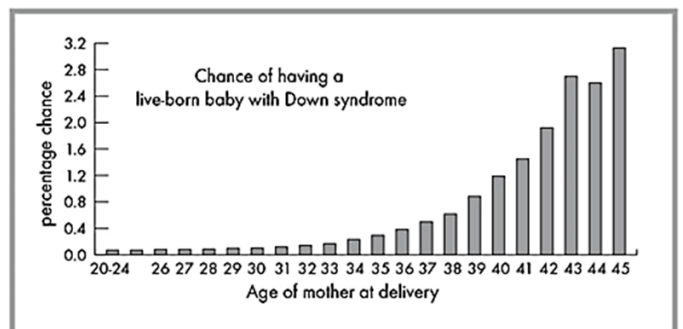
**Figure 36.5:** A picture (karyotype) of the chromosomes from a woman with a ‘balanced’ Robertsonian translocation between chromosomes 21 and 14.

**HOW IS DOWN SYNDROME INHERITED?**

In most cases where Down syndrome is caused by a complete extra copy of chromosome 21, that person will be the first and only person affected by the condition in that family.

It is usually assumed that if the parents of a person with Down syndrome have the usual two copies of chromosome 21, then the extra 21 in their child was a result of an egg or sperm with 24 instead of 23 chromosomes being fertilised.

Older mothers are more likely to have these errors in chromosome number occur in their eggs. This is why Down syndrome is often discussed with older mothers. Figure 36.6 shows the statistics for the chance of having a baby with Down syndrome as a mother gets older.



Age of mother at delivery	Chance of having a live-born baby with Down syndrome	Age of mother at delivery	Chance of having a live-born baby with Down syndrome
20-24 years	1 in 1411	35 years	1 in 338
25 years	1 in 1383	36 years	1 in 259
26 years	1 in 1187	37 years	1 in 201
27 years	1 in 1235	38 years	1 in 162
28 years	1 in 1147	39 years	1 in 113
29 years	1 in 1002	40 years	1 in 84
30 years	1 in 959	41 years	1 in 69
31 years	1 in 837	42 years	1 in 52
32 years	1 in 695	43 years	1 in 37
33 years	1 in 589	44 years	1 in 38
34 years	1 in 430	45 years	1 in 32

**Figure 36.6:** Chance of having a live-born baby with Down syndrome (trisomy 21) according to the mother’s age at the time of delivery of the baby. (Sources: Morris JK, Mutton DE and Alberman E (2002) Revised estimates of maternal age specific live birth prevalence of Down syndrome. *Journal of Medical Screening*. 9, 2-6).

For parents who have a child with a Robertsonian translocation form of Down syndrome, there may be more tests needed to determine whether the chromosome rearrangement in the child has occurred as a new (spontaneous) rearrangement or not. Depending on the findings of these additional tests (on the child and parents), the chance of another child having Down syndrome can vary.

### **IS THERE ANY TESTING AVAILABLE FOR DOWN SYNDROME?**

Chromosome testing of a baby who is suspected of having Down syndrome can be done using a blood sample. A doctor may suspect a baby has the condition based on observing the characteristic facial features or other symptoms such as a heart problem or low muscle tone.

#### **Prenatal testing and PGD**

Testing for Down syndrome may be offered during pregnancy to some couples, especially for those women who are 35 years or older.

Prenatal tests can occur in a number of different ways and at certain stages of the pregnancy. In general, there are two main types of prenatal test – a screening test and a diagnostic test.

*Screening tests* give a risk or estimate of the probability that a baby has a health problem. These tests do not generally look directly at a sample from the developing baby and are therefore very safe. Included in the group of screening tests are ultrasounds, non-invasive prenatal testing, first trimester screening and second trimester screening.

*Diagnostic tests* provide a more accurate result since they are directly testing the baby. Because of this, the tests also may cause a loss of the baby in a small number of cases. Included in the group of diagnostic tests are ultrasounds, chorionic villus sampling (CVS) and amniocentesis.

Testing during pregnancy is optional and should be discussed in full with your doctor, midwife or genetic counsellor. Making a decision to have a test or not is always up to you.

It may also be possible to undergo pre-implantation genetic diagnosis (PGD) screening for Down syndrome on an embryo created using in vitro fertilisation (IVF). These options are best discussed and considered before pregnancy, when possible, in order to ensure all possible risks, benefits and outcomes can be explored.