
Understanding Relationships: Part Two – How much DNA do we share?

[Part One of this information sheet](#) concentrated on finding the correct terminology for relationships between family members and explaining why precise descriptions are important. Part Two looks at the amounts of DNA these relatives would be expected to share and how to begin to work out where unknown matches might fit into your tree.

This is not intended to be a detailed scientific guide (there are many resources available online if you want to get into the technicalities of DNA further) but aims to give you an overview of how shared DNA and relationships work together.



How is shared DNA measured?

Shared autosomal DNA can be expressed in **centiMorgans**, which you will often see abbreviated as **cMs** (not to be confused with centimetres)! DNA can also be expressed in **percentages** (displayed on 23andMe and MyHeritage). The more cMs/higher the percentage shared with someone, the closer the relationship is between you. The closest relationships are between a parent and child (or identical twins) and they would share approximately 3,500 cMs.

Do I share autosomal DNA with all my relatives that have ever lived?

The short answer is no! DNA is passed down from parent to child. Both your parents passed on 50% of their DNA to create a child that is 100% "you". Therefore, 50% of your Mother's DNA was *not* passed on to you, and similarly, 50% of your Father's DNA was not passed on either. Every child is unique (apart from identical twins...) so, although you and all your siblings are made to the same "recipe" of 50% Mother's DNA and 50% Father's DNA, each child will inherit a different selection of the available DNA from each parent.

If you look many generations into the future, the DNA that you inherited from your parents will eventually stop being passed on to the next generation. For example, you inherited half your Mother's DNA and will pass a sizeable amount of her DNA on to your children. They, in turn, will pass some of their share of your Mother's DNA on to their children. The amount passed on is likely to get progressively smaller and, at some point, whatever remains of your Mother's DNA in your (multiple great) grandchild will be amongst the DNA that they do not pass on to their child.

However, it takes several generations before having no DNA in common between present-day relatives becomes a possibility – relatives who are 2nd cousins or closer should show as sharing DNA when tested.

If two people are third cousins, there is a 10% chance that they will not share any of the DNA that could have been passed down from their common set of great-great-grandparents. When two people are related as fourth cousins the likelihood of not sharing DNA increases to a 50% chance.

So, it **is** possible for you to be related to someone as a third or fourth cousin but have no DNA in common – the absence of shared DNA at a third/fourth cousin level does not mean that your family tree is wrong! If other members of your family decide to test, you may find that they match third/fourth cousins that you don't. For example, if your sister matches a fourth cousin but you don't, it would be because your parent passed on DNA from the common ancestor to your sister, but not to you.

My results say we are first cousins – is that wrong?

The DNA testing companies use categories to describe how closely you are related to your matches (eg, *Close Family* or *3rd – 5th cousin*).

These category headings cover many possible relationships, which can cause confusion. For example, the amount of DNA shared between you and your uncle or aunt is similar to the amount shared between you and your grandparents, your grandchildren, your nieces, nephews or your half-sibling – and a testing company has no way of knowing which relationship out of this selection is the right one. Further research on your part will help – eg, if you discover that your match is two years younger than you, you know they will not be your grandmother or granddaughter, but they could be a half-sister or niece.

To identify the correct relationship between you and a match, you need to find the total shared DNA in cMs, consider all the relationships that could fit this amount (there are links to charts to help you with this on the next page) and then use record-based research to find the relationship between the two of you.

How can I tell how many centiMorgans I share with a match?

All the major autosomal DNA sites tell you how much DNA you share with your matches, either as cMs and/or as a percentage, but some make this figure easier to find than others – see the (soon to be published) information sheet ***Where are my centiMorgans?*** for information on where this figure is shown on each of the different sites.

However, finding the total shared cMs is not the end of the story... A number of other factors to bear in mind include:

- The way in which your total shared cMs is calculated varies from company to company – they all have different methods (***algorithms***).
- Some companies give a total indicating your shared DNA across all 23 of your chromosomes, others only report the total from chromosomes 1 - 22 (your ***autosomal*** DNA). Chromosome 23 determines whether you are male (XY) or female (XX) and has a particular inheritance pattern, so is often considered separately from the other chromosomes.
- The DNA you share with someone else will be in “chunks” (***segments***). The total DNA two people share could be from many segments on many chromosomes, just one segment on one chromosome, or multiple segments on the same chromosome. Each company has a different approach to dealing with smaller segments of shared DNA. One company’s calculations may deem a very small segment of shared DNA significant enough to count towards your shared total, whilst another will disregard it totally.

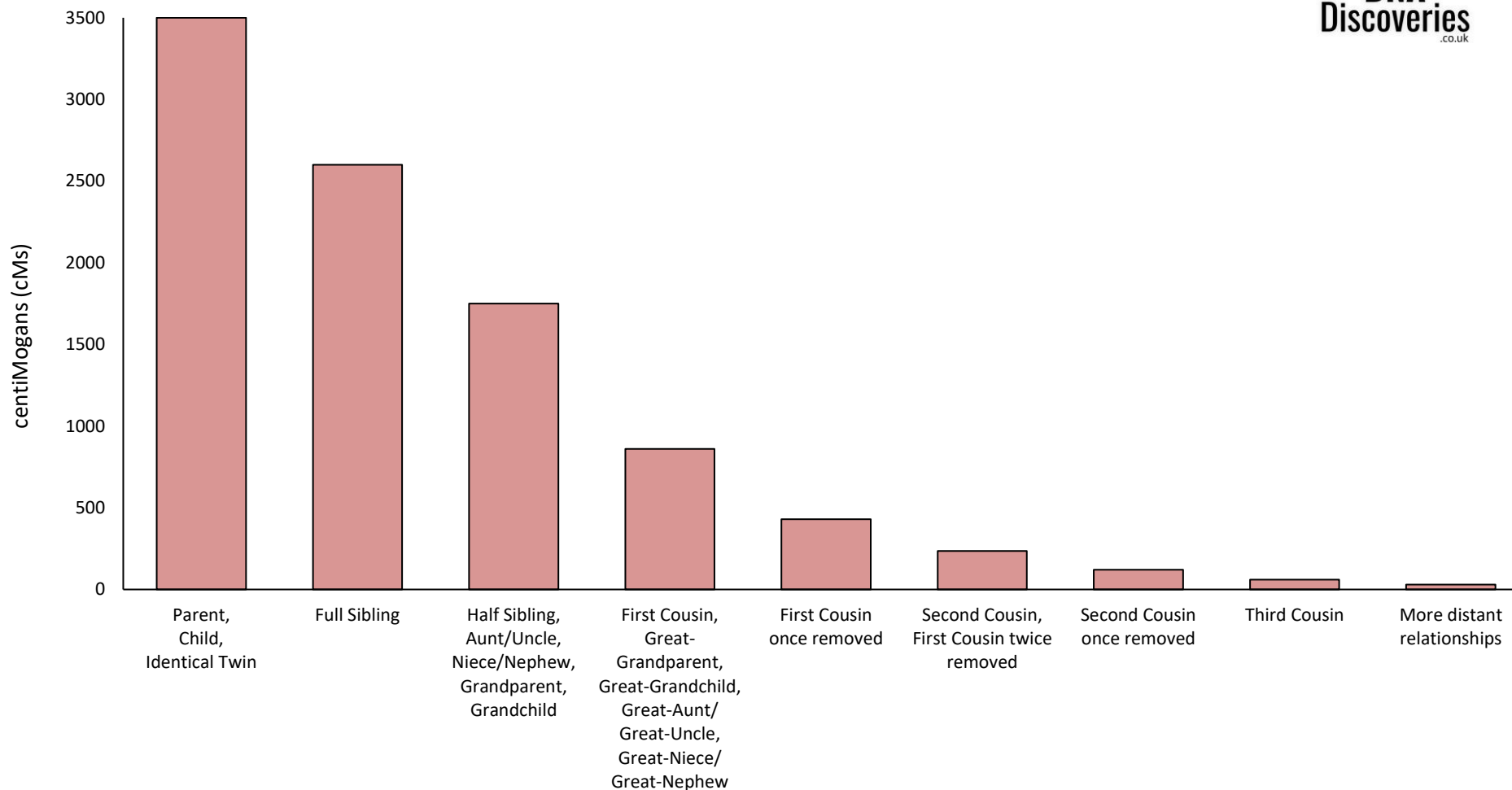
I have a third cousin who matches me on all the major testing/comparison sites. Our predicted relationship appeared in categories that varied from “1st cousin twice removed - 4th cousins” through to “4th - 6th cousins” and our shared cMs varied from 62 to 85 cMs. After taking into consideration the differences in the different companies’ calculations, the amended total was similar across most of the sites and within the normal range for third cousins.

How many cMs are we talking about?

The chart on the next page shows rough averages of shared DNA for a variety of relationships (but not ***all*** the possible relationships by any stretch of the imagination). As you will see, the amount decreases rapidly as the relationships become more distant. It is worth noting the difference that being once or twice “removed” in a relationship can make – and therefore why it is important to be able to describe relationships accurately.

Shared centiMorgans and examples of possible relationships

(This chart is intended to demonstrate how rapidly the cMs decrease as relationships become more distant - the figures are only rough averages)



Relationships listed are examples of some of the possibilities - half relationships are amongst others that should also be considered

Shared cM charts

There are many charts available online which show amounts of shared DNA and the possible relationships – or looking at it the other way, the known relationship and anticipated amount of DNA. Everyone’s mind works differently, so if you may one find that “clicks” with you – print it out and put it somewhere easy to find as you are likely to refer to it frequently once your results are available.

The two charts that I refer to most regularly are:

DNA Detectives Autosomal Statistics Chart - Christa Stalcup (reproduced with permission) (often referred to as "The Green Chart")

If you are already a member of the [DNA Detectives Facebook Group](#) you can find this document in the [Files section of the group](#) – the illustration to the right is just to give you an idea of what it looks like. There are two pages – make sure you look at the explanations and notes on the second page as well.

DNA Detectives Autosomal Statistics Chart						
cM (centiMorgans)^		Percentage (%) of Shared DNA^^		Group	Relationship	Notes
Average	Range	Average	Range			
3,600		50%			Parent - Child	
2650	2300 - 3900	37%	32% - 54%	Group A	Full Sibling	Ancestry, FTDNA and GEDmatch (HIR only)
3600		50%				23andMe (FIR included)
1800	1300 - 2300	25%	18% - 32%	Group B	Half Sibling Aunt/Uncle/Niece/Nephew Double First Cousin Grandparent/Grandchild	3/4 Siblings***
900	575 - 1330	12.5%	8% - 18.5%	Group C	First Cousin (1C) Half Aunt/Uncle/Niece/Nephew Great-Grandparent/Great-Grandchild Great-Aunt/Uncle/Niece/Nephew	
450	215 - 650	6.25%	3% - 9%	Group D	First Cousin Once Removed (1C1R) Half First Cousin (1/2 1C) Half Great-Aunt/Uncle/Niece/Nephew	
224	75 - 360	3.125%	1% - 5%	Group E	Second Cousin (2C) First Cousin Twice Removed (1C2R) Half First Cousin Once Removed (1/2 1C1R)	
112	30 - 215	1.56%	0.42% - 3%	Group F	Second Cousin Once Removed (2C1R) Half Second Cousin (1/2 2C) First Cousin Three Times Removed (1C3R) Half First Cousin Twice Removed (1/2 1C2R)	
56	0 - 109*	0.78%	0% - 1.52%	Group G	Third Cousin (3C) Second Cousin Twice Removed (2C2R)	~10% of 3Cs will not share DNA*
30	0 - 75**	0.4%	0% - 1%	Group H	Third Cousin Once Removed (3C1R) Other Distant Cousins	~50% of 4Cs will not share DNA**

^cM - Ancestry.com & FTDNA
^^Percentage of DNA - 23andMe
*** 3/4 Siblings are a combination of half siblings and 1st cousins. FIRs are included.

Groups A & B: 90% within the ranges given
Groups C - I: 95% within the ranges given

The Shared cM Project - Blaine Bettinger (also known as The Genetic Genealogist and founder of the Genetic Genealogy Tips and Tricks Facebook Group)

This project has just been updated (August 2017) and the current report and charts can be found [here](#) – again, the illustration is purely to give you an idea of what you’re looking for, not an eyesight test!

This is an ongoing project, so the best place to download the current version is from the ISOGG website (scroll down to the heading **Distribution of genealogical relationships for given amounts of shared DNA**): [The Shared cM Project](#)

The Shared cM Project – Version 3.0 For MUCH more information (including histograms and company breakdowns) see: goo.gl/ZiEoQ

August 2017
Blaine T. Bettinger
www.TheGeneticGenealogist.com
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How to read this chart:
Relationship Average Range (low-high) (99% Percentile)
Aunt/Uncle 1750 46-2175*

Minimum was automatically set to 0 cM for relationships more distant than Half 2C, and averages were determined only for submissions in which DNA was shared

Online Relationship Calculators

You can find various websites which compare cMs and predict relationships. I find this one particularly useful:

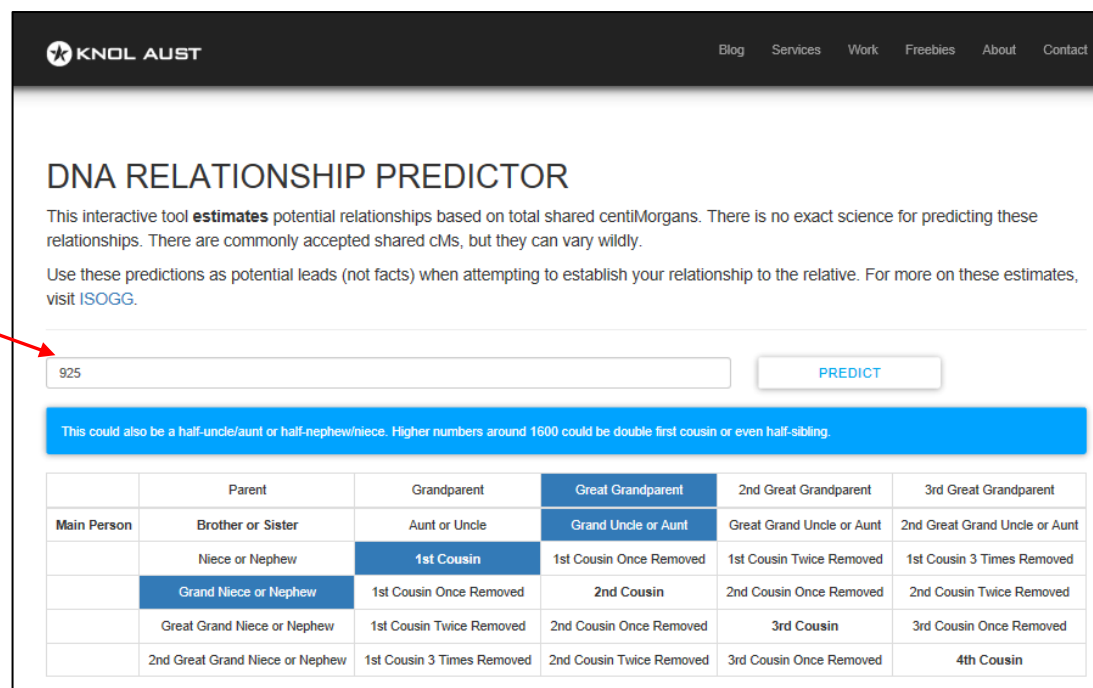
<https://knolaust.com/dna/>

Simply **type in the number of cMs**

and click the button marked **Predict** to see possible relationships:

- full relationships appear shaded on the grid

- other possibilities, eg half-relationships, are listed in the bar above the grid.



DNA RELATIONSHIP PREDICTOR

This interactive tool **estimates** potential relationships based on total shared centiMorgans. There is no exact science for predicting these relationships. There are commonly accepted shared cMs, but they can vary wildly.

Use these predictions as potential leads (not facts) when attempting to establish your relationship to the relative. For more on these estimates, visit ISOGG.

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This could also be a half-uncle/aunt or half-nephew/niece. Higher numbers around 1600 could be double first cousin or even half-sibling.

	Parent	Grandparent	Great Grandparent	2nd Great Grandparent	3rd Great Grandparent
Main Person	Brother or Sister	Aunt or Uncle	Grand Uncle or Aunt	Great Grand Uncle or Aunt	2nd Great Grand Uncle or Aunt
	Niece or Nephew	1st Cousin	1st Cousin Once Removed	1st Cousin Twice Removed	1st Cousin 3 Times Removed
	Grand Niece or Nephew	1st Cousin Once Removed	2nd Cousin	2nd Cousin Once Removed	2nd Cousin Twice Removed
	Great Grand Niece or Nephew	1st Cousin Twice Removed	2nd Cousin Once Removed	3rd Cousin	3rd Cousin Once Removed
	2nd Great Grand Niece or Nephew	1st Cousin 3 Times Removed	2nd Cousin Twice Removed	3rd Cousin Once Removed	4th Cousin

Unexpected Results

You may find that your DNA results confirm the relationships in the family tree that you have already researched. However, by comparing relationships established via traditional research and by shared DNA you may discover some of the biggest surprises of DNA testing – for example, you could discover that:

- Your sister is actually your half-sister
- You have a half-sibling, cousin or other close relative that you were previously unaware of
- A more distant relative on the tree you have spent decades researching, on a line you are particularly proud of, is not actually your relative at all.

Discoveries like these can be difficult to come to terms with. The possibility of finding something unexpected needs to be considered before testing, especially if you plan to manage a test on behalf of another person and therefore could potentially have to deal with these types of discoveries about their family.

For further help discovering your DNA family, [visit DNADiscoveries.co.uk](http://visitDNADiscoveries.co.uk)



or



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